City of Bonner Springs Water Supply & Treatment Plant Project

WIFIA Letter of Interest

Appendix A: Facility Plan

FINAL

CITY OF BONNER SPRINGS WATER SUPPLY AND TREATMENT PLANT STUDY

Facility Plan

B&V PROJECT NO. 404408

PREPARED FOR

City of Bonner Springs, Kansas

18 MAY 2020

BLACK & VEATCH

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1.0 General

1.1 PROJECT DESCRIPTION

The City of Bonner Springs Water Treatment Plant Project will include construction of a green field high rate precipitative softening plant (WTP) adjacent to existing utility operations buildings near the existing water treatment plant. The existing plant will not be reused or incorporated into the new facility. The new 2.0 MGD firm capacity plant is based on recommendations from the Water Treatment Technology Evaluation dated March 2020 and will include the following:

- Operations Building to house chemicals and provide working space for operations and maintenance; space will include offices, meeting/lunch room, restrooms, server/safe room, controls room, parts storage, laboratory, electrical room, filter gallery and chemical storage rooms.
- High rate packaged treatment systems; skids will include basins for rapid mix, reactor and a clarifier/thickener. The system will be designed for two 100% capacity trains.
- Recarbonation basin with a CO2 tank and feeders.
- Packaged gravity filters; skids will be located within the new Operations Building. The system will be designed for plant firm capacity with one filter off-line for backwashing.
- Filter backwash storage tank and pumping station.
- Packaged Lime Storage and Feed System including storage silo, lime feeders, slaker, slurry storage tank, slurry feed pumps and associated piping, valves and appurtenances.
- Packaged Soda Ash Storage and Feed System including storage silo, solution tank, solution feed pumps and associated piping, valves and appurtenances.
- Sodium hypochlorite Storage and Feed System consisting of tote storage, metering pumps and associate piping, valves and appurtenances. The sodium hypochlorite system will be housed in the Operations Building.
- Coagulant Storage and Feed System consisting of tote storage, metering pumps and associate piping, valves and appurtenances. The coagulant system will be housed in the Operations Building.
- Fluoride Storage and Feed System consisting of tote storage, day tank, metering pumps and associate piping, valves and appurtenances. The fluoride system will be housed in the Operations Building.
- Phosphate Storage and Feed System consisting of tote storage, metering pumps and associate piping, valves and appurtenances. The phosphate system will be housed in the Operations Building.
- Liquid Ammonium Sulfate Storage and Feed System consisting of tote storage, metering pumps and associate piping, valves and appurtenances. The liquid ammonium sulfate system will be housed in the Operations Building.
- Polymer Storage and Feed System consisting of tote storage, metering pumps and associate piping, valves and appurtenances. The polymer system will be housed in the Operations Building.
- Treated Water Reservoir consisting of a below grade concrete basin.

- High Service Pump Station located above the Treated Water Reservoir containing three high service discharge pumps and one backwash supply pump and associated piping, valves and appurtenances.
- Lime Residual Treatment Facility (earthen lagoon) located in an adjacent property for storage of lime residuals.

1.2 BACKGROUND

The City of Bonner Springs' existing Water Treatment Plant is located on Swingster Road, southeast of the intersection of Kansas Highway 32 and K-7. The plant consists of a pressure filter system targeting iron and magnesium removal with a total production rate of 900 to 1,000 gpm (1.28 to 1.42 MGD). This system does not have redundancy to meet current average day demands if one filter is offline. The utility has connections to the Board of Public Utilities (BPU) and an agreement to purchase additional water. Neither the existing plant or BPU produce softened water.

1.3 SCHEDULE

The following Table 1-1 is a summary of key project dates.

Table 1-1 Project Schedule

PROJECT MILESTONE OR TASK	DATE OR ANTICIPATED DURATION (MONTHS)
Submit Final Facility Report	May 2020
Prepare and Submit Final Design Bid Documents	February 2021 9 months
Regulatory Review	April 2021 2 months
Advertisement and Award	June 2021 2 months
Construction	June 2023 24 months

1.4 SITE DESCRIPTION

1.4.1 Location

The new WTP will be located east of the existing water treatment plant and utility buildings along Swingster Road. Source water will be supplied to the plant from four existing groundwater wells.

1.4.2 Datum

Elevations used on this project will be NAVD88 datum. Horizontal control will be based on the state plane coordinate system. Benchmarks for vertical and horizontal control will be established through a project survey.

1.5 APPLICABLE CODES, REGULATIONS, AND STANDARDS

1.5.1 Applicable Design Codes and Standards

The design of new facilities will be based on, but not limited to the following codes and standards.

- International Building Code (IBC), 2015 Edition
- International Mechanical Code (IMC), 2015 Edition
- International Plumbing Code (IPC), 2015 Edition
- International Fire Code (IFC), 2015 Edition
- National Electrical Code (NEC), 2014 Edition
- Kansas Department of Health and Environment (KDHE) Public Water Supply Section Design Standards 2008

1.5.2 Anticipated Permits

All applicable City and State Construction permits will be identified during design including but not limited to the following:

- Building
- Stormwater
- Wastewater
- Land disturbance
- Public works
- KDHE

1.6 GEOTECHNICAL AND SURVEY INFORMATION

1.6.1 Geotechnical

Black & Veatch retained the services of Geotechnology, Inc. as a subcontractor to perform preliminary field investigations, laboratory testing, and preliminary foundation design recommendations from a single boring in the vicinity of the new treatment plant Operations Building. Preliminary evaluations found fat clays at the site. Some mitigation will be required for foundations through soil replacement. No deep foundations are anticipated based on current weights and loadings facilities and structures. Reference Appendix D – Geotechnical Report for additional information. Additional geotechnical investigations should be conducted during detailed design to confirm conditions across the site and provide recommendations if required.

1.6.2 Survey

No survey was performed for this report. Completing a survey during detailed design is recommended to confirm site elevations at the location for the new plant and lime residual treatment facility.

1.7 DOCUMENTS

1.7.1 Drafting Standards

Electronic drawings will be produced using Revit and AutoCAD 2019. Black & Veatch Water standards, as modified by the Drafting Coordinator, will be implemented on the project. Review submittals at each detailed design milestone will be issued on standard (11-inch x 17-inch) "B" size sheets with Black & Veatch standard project border modified with project specific requirements. Upon completion, all final CAD drawings will be submitted on standard 22-inch by 34-inch sheets. Each sheet will bear the following general title:

City of Bonner Springs, Kansas
Water Treatment Plant

Design submittals and bid drawings will also be provided to the Owner in PDF format.

1.7.2 Specifications

Black and Veatch standard technical specifications and front end documents will be used and modified as required to suit the project. Standard front end documents (based on the Engineers Joint Contract Documents Committee) will be used.

1.7.3 References

The following reference materials will be referred to during design:

- A March 2019 report prepared for the City of Bonner Springs by Bartlett & West, titled "Water System Master Plan 2019 Update".
- A May 2020 report prepared for the City of Bonner Springs by Black & Veatch, titled "Water Supply Evaluation".
- A May 2020 report prepared for the prepared for the City of Bonner Springs by Black & Veatch, titled "Water Treatment Technology Evaluation".
- An April 2019 report prepared for the City of Bonner Springs by Geotechnology, Inc. titled "Preliminary Geotechnical Exploration Water Supply and Treatment Plant Study Bonner Springs, Kansas".

2.0 Process Design Criteria

The new WTP will be designed in accordance with the process design criteria described in this Chapter.

2.1 RAW WATER QUALITY

Raw water is sourced from several vertical wells drawing from the Kansas River Alluvial Aquifer. Water quality data on well water is limited and has been supplemented by water quality data from neighboring well fields. The groundwater contains high calcium and magnesium hardness and has significant levels of iron and manganese. Water quality used as the design basis is summarized in Table 2-1. Unless otherwise noted, the values shown in Table 2-1 were obtained from the City's *Water System Master Plan*, updated in March 2019.

Table 2-1 Raw Water Quality Summary

CONSTITUENT	MCL (SMCL)	AVERAGE VALUE
pH	(6.5 – 8.5)	7.2
Sodium, mg/L	-	68
Calcium[1], mg/L as $CaCO_3$	-	349
Magnesium, mg/L as $CaCO_3$	-	91
Total Hardness, mg/L as $CaCO_3$	-	440
Alkalinity, mg/L as $CaCO_3$	-	220
Chloride, mg/L	(250)	108
Sulfate, mg/L	(250)	195
Fluoride, mg/L	4 (2)	0.4
Nitrate, mg/L	10	0.4
TDS, mg/L	(500)	760
Iron, mg/L	(0.3)	0.2
Manganese, mg/L	(0.05)	2.0
Silica, mg/L	-	21
TOC[2], mg/L	-	1.79
HAA5s, µg/L (in finished water[1])	60	21
TTHMs, µg/L (in finished water[1])	80	45

CONSTITUENT	MCL (SMCL)	AVERAGE VALUE
Turbidity[2], mg/L	-	33

Notes:
1. Value from City of Bonner Springs 2017 Consumer Confidence Report.
2. Value from neighboring well field also on the Kansas River Alluvial Aquifer.

2.2 TREATED WATER GOALS

The primary treated water quality goal of this project is to produce finished water having a total hardness of 150 mg/L as CaCO3. This goal is consistent with the finished water hardness values of other local utilities.

Other water quality goals are to reduce the concentrations of constituents exceeding National Primary and Secondary Drinking Water Standards. Primary drinking water standards are enforceable while secondary drinking water standards are non-enforceable guidelines based on cosmetic or aesthetic effects. The only water quality constituents known to exceed the secondary drinking water standards at this time are manganese and total dissolved solids (TDS). Iron is included due to its tendency to coexist with manganese.

A final water quality goal is to produce finished water that is not corrosive to materials in the distribution system. This is generally achieved by ensuring the finished water conveyed to the distribution system will slightly promote scale formation. Metrics used to measure scale formation and corrosivity of water are the Langelier saturation index (LSI) and the calcium carbonate precipitation potential (CCPP). An LSI value between 0 and 1 and a CCPP value between 4 and 10 are indicative of water that is slightly, but not overly, scaling. Treated water quality goals for this project are summarized in Table 2-2.

Table 2-2 Treated Water Quality Goals

CONSTITUENT	GOAL
Total Hardness, mg/L as CaCO3	150
TDS, mg/L	< 500
Iron, mg/L	< 0.3
Manganese, mg/L	< 0.05
Langelier Saturation Index (LSI)	0 – 1
Calcium Carbonate Precipitation Potential (CCPP)	4 – 10

2.3 DESIGN PRODUCTION RATES

The new plant will be designed to produce a firm treatment capacity of 2.0 million gallons per day (MGD) when operated continuously with capability of turndown to demands as low as 0.40MGD. Provisions are included for the addition of another treatment train to expand the WTP to a firm

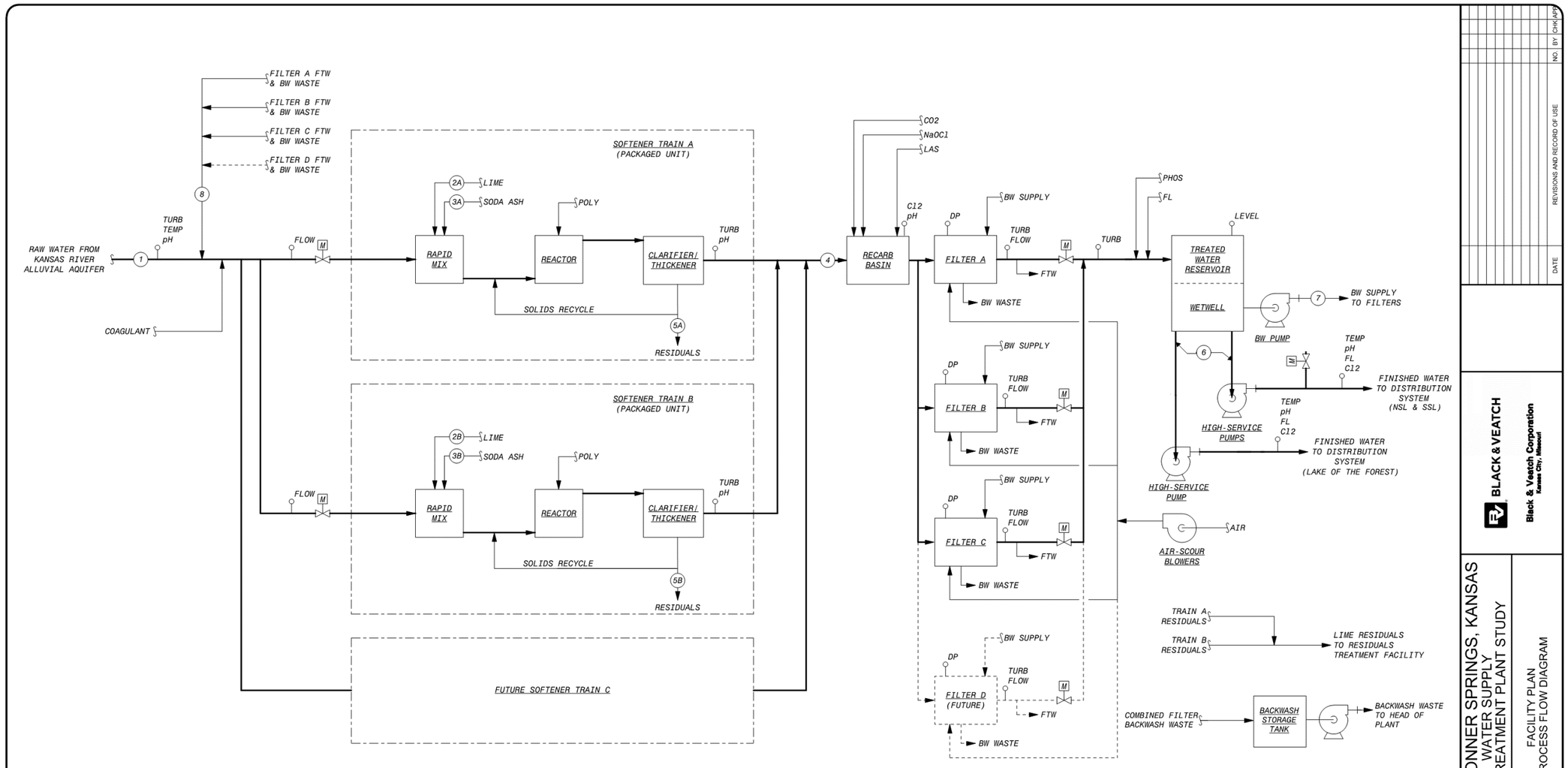
capacity of 3.0 MGD in the future. Refer to Table 2-3 for summary of treatment plant production rates.

Table 2-3 Treatment Plant Production Rates

PRODUCTION DESIGN RATES	FLOW (MGD)
Minimum Production[1]	0.4
Average Production[2]	1.1
Peak, Firm Capacity	2.0
Future Peak, Firm Capacity	3.0

Notes:
1. Minimum production rate based on turndown capability for precipitative softening technology. Membrane softening technology is operated on an on/off basis and would lower production by running fewer hours in a day.
2. Value from 2019 Master Plan for year 2020

Reference Figure 2-1 and Figure 2-2 for the Process Flow Diagram and Hydraulic Profile respectively.



ABBREVIATIONS

BW	BACKWASH
COND	CONDUCTIVITY
C12	CHLORINE
CO2	CARBON DIOXIDE GAS
DP	DIFFERENTIAL PRESSURE
FL	FLUORIDE
FLOW	FLOW METER
FTW	FILTER-TO-WASTE
LAS	LIQUID AMMONIUM SULFATE
LIME	QUICKLIME/CALCIUM OXIDE
NaOCl	SODIUM HYPOCHLORITE
pH	pH CELL
PHOS	PHOSPHATE/POLYPHOSPHATE
POLY	POLYMER
TEMP	TEMPERATURE
TURB	TURBIDITY

STREAM	1	2A + 2B	3A + 3B	4	5A + 5B	6	7	8
DESCRIPTION	RAW WATER FROM WELLS	LIME	SODA ASH	SOFTENER EFFLUENT	LIME SLUDGE	FINISHED WATER	BACKWASH SUPPLY	BACKWASH WASTEWATER
FLOW, GPD	2,044,429	---	---	2,045,000	44,429	2,000,000	45,000	45,000
TDS, mg/L	808	---	---	489	489	489	489	489
SOLIDS, LB/DAY	842	3,105	1,954	768	11,119	---	---	768
% SOLIDS	0.005%	100%	100%	0.005%	3.00%	---	---	0.205%
CONTINUOUS/INTERMITTENT	CONTINUOUS	CONTINUOUS	CONTINUOUS	CONTINUOUS	INTERMITTENT	CONTINUOUS	INTERMITTENT	INTERMITTENT

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	BY	CHK/APP	DATE	REVISIONS AND RECORD OF USE

BLACK & VEATCH
Black & Veatch Corporation
Kansas City, Missouri

CITY OF BONNER SPRINGS, KANSAS
WATER SUPPLY
AND TREATMENT PLANT STUDY

FACILITY PLAN
PROCESS FLOW DIAGRAM

DESIGNED:
DETAILED:
CHECKED:
APPROVED:
DATE:

0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE

PROJECT NO.
404408

SHEET
OF

Figure 2-1 Process Flow Diagram

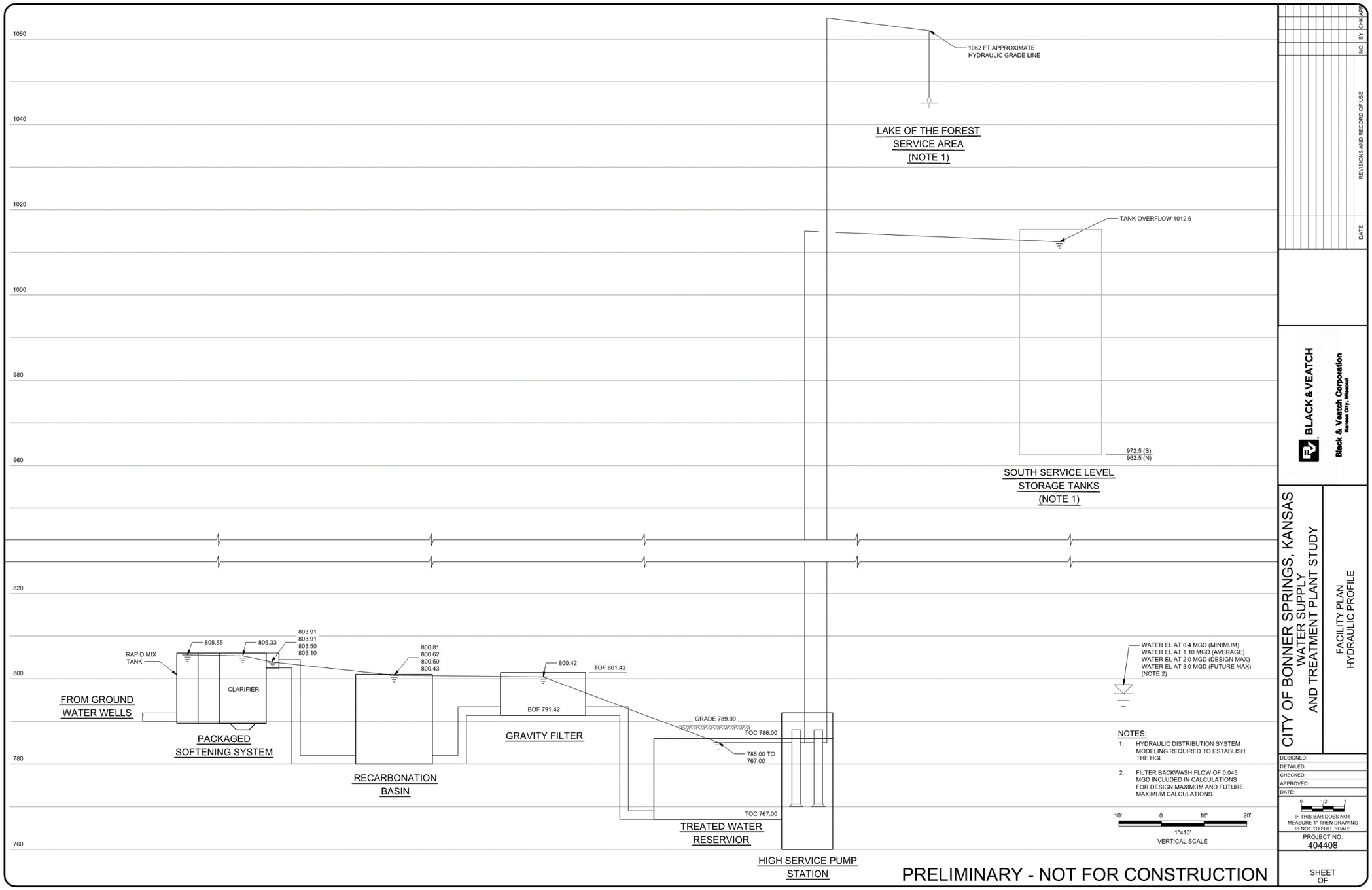


Figure 2-2 Hydraulic Profile

3.0 Treatment Facilities

3.1 HIGH-RATE PACKAGED CLARIFIER EQUIPMENT

High rate packaged clarifier units will be located on an exterior pad south of the new Operations Building. Flow will enter the system from the well field after flow metering. The high-rate precipitative softening equipment consists of packaged high-rate clarifier units with reactors and rapid mix basins. Lime and soda ash are fed into the rapid mix basin on each train from nearby packaged chemical feed systems. Coagulant is fed to the inlet of the treatment trains and polymer is fed to the reactor for optimization of the softening process. Table 3-1 includes preliminary details for the high rate clarifiers. Reference Figure 3-1 Site Plan for the location of the high rate packaged clarifier units.

Table 3-1 High-Rate Precipitative Softening Equipment Design Criteria

PARAMETER	DESIGN CRITERIA
High-Rate Clarifier Units	
Quantity	2 (1 duty, 1 standby)
Rated flow, MGD, each	2.0
Basin type	Coated carbon steel tanks
Clarifier loading rate, gpm/sf	7.7
Ancillary equipment	Mixers, residuals collector, residuals pumps, plates/tubes, collection troughs, instrumentation, controls

3.2 COAGULANT STORAGE AND FEED SYSTEM

A new coagulant (aluminum sulfate) storage and feed system will be located in the new Operations Building and will include totes, metering pumps, and appurtenances. Coagulant will be fed to the common header of the packaged high rate clarifier system. Reference Table 3-2 for design criteria of the new coagulant storage and feed system. Reference Figure 3-2 for the new Operations Building plan for the layout of the coagulant storage and feed system.

Table 3-2 Coagulant Storage & Feed System Design Criteria

PARAMETER	DESIGN CRITERIA
Chemical Information	
Delivered chemical, specific gravity (SG)	48.5% Aluminum Sulfate, SG = 1.335
Feed chemical, specific gravity (SG)	48.5% Aluminum Sulfate, SG = 1.335
Feed points	Influent header of packaged clarifier equipment
Plant Water Flow	
Average, MGD	1.2
Maximum, MGD	2

PARAMETER	DESIGN CRITERIA
Chemical Dosage as Feed Chemical	
Average, mg/L	20
Maximum, mg/L	20
Chemical Feed Flow as Feed Chemical	
Average, gph	1.5
Maximum, gph	2.6
Aluminum Sulfate Storage	
Type	Tote
Quantity	4
Materials	HDPE
Capacity, gallons, each	330
Total storage, gallons	1,320
Required storage for 30 days, gallons	1,112
Average storage, days (1)	36
Dimensions	
Length, feet	4
Width, feet	4
Height, feet	4
Aluminum Sulfate Metering Pumps	
Quantity	2 (1 duty + 1 standby)
Type	Tube type peristaltic metering pump
Capacity range, gph (2)	0.03 to 2.6
Turndown ratio, per pump	100:1
Control	Automatic and manual start/stop. Automatic and manual speed control with local override.
Pipe Material	PVC
Valve Type	Ball

Notes:
1. Days of storage based on total storage.
2. Minimum metering pump capacity is based on pump turndown.
3. Future 2 MGD average plant flow will require 1,900 gallons for 30 days of storage. One 2,500 gallon tank or six 330 gallon totes will be required for the future condition.

3.3 LIME STORAGE AND FEED SYSTEM

A new packaged lime storage and feed system will be located on an exterior pad located west of the packaged high-rate clarifiers. Lime will be fed to Rapid Mix Basin No.1 and Rapid Mix Basin No.2 of the high-rate clarifiers. Reference Table 3-3 for design criteria of the new lime storage and feed system. Reference Figure 3-1 Site Plan for the location of the lime storage and feed system.

Table 3-3 Lime Storage & Feed System Design Criteria

PARAMETER	DESIGN CRITERIA
Chemical Information	
Delivered chemical, bulk density (BD)	90% Quick Lime, BD = 55 lb/ft3
Feed chemical, bulk density (BD)	90% Quick Lime, BD = 55 lb/ft3
Feed points	Rapid Mix Basin No. 1 Rapid Mix Basin No. 2
Plant Water Flow	
Average, MGD	1
Maximum, MGD	2
Chemical Dosage as Feed Chemical	
Average, mg/L	217
Maximum, mg/L	217
Chemical Feed Flow as Feed Chemical	
Average, pph	84
Maximum, pph	168
Lime Storage	
Type	Silo
Quantity	2 (one per unit)
Materials	CS
Capacity, ft3, each	1,150
Total storage, ft3	2,300
Required storage for 30 days, gallons	1,100
Average storage, days (1)	62
Dimensions	
Diameter, feet	12
Straight side height, feet	10
Cone height, feet	9

PARAMETER	DESIGN CRITERIA
Lime Feeder	
Quantity	2 (one per unit)
Type	Rotary Vane Feeder
Capacity, pph	250
Control	Automatic and manual start/stop. Automatic and manual speed control with local override.
Lime Detention Slaker	
Quantity	2 (one per unit)
Type	Vertical Cylindrical
Materials	SS
Capacity, pph	250
Lime Grit Remover	
Quantity	2 (one per unit)
Type	Screw
Motor, hp	1/3
Lime Slurry Tank	
Quantity	2 (one per unit)
Type	Vertical Cylindrical
Materials	SS
Capacity, gal	500
Lime Slurry Feed Pumps	
Quantity	4 (two per unit)
Type	Horizontal Centrifugal
Capacity, gpm	70
Control	Automatic and manual start/stop. Automatic and manual speed control with local override.
Pipe Material	CS
Valve Type	Ball/Pinch
Notes: 1. Days of storage based on total storage.	

3.4 SODA ASH STORAGE AND FEED SYSTEM

A new packaged soda ash storage and feed system will be located on an exterior pad west of the packaged high rate clarifier system. Soda ash will be fed to Rapid Mix Basin No.1 and Rapid Mix Basin No.2. Reference Table 3-4 for design criteria of the new soda ash storage and feed system. Reference Figure 3-1 Site Plan for the location of the soda ash storage and feed system.

Table 3-4 Soda Ash Storage & Feed System Design Criteria

PARAMETER	DESIGN CRITERIA
Chemical Information	
Delivered chemical, bulk density (BD)	99% Soda Ash, BD = 65 lb/ft3
Feed chemical, bulk density (BD)	99% Soda Ash, BD = 65 lb/ft3
Feed points	Rapid Mix Basin No. 1 Rapid Mix Basin No. 2
Plant Water Flow	
Average, MGD	1
Maximum, MGD	2
Chemical Dosage as Feed Chemical	
Average, mg/L	140
Maximum, mg/L	140
Chemical Feed Flow as Feed Chemical	
Average, pph	76
Maximum, pph	153
Soda Ash Storage	
Type	Silo
Quantity	1
Materials	CS
Capacity, ft3, each	1,000
Total storage, ft3	1,000
Required storage for 30 days, gallons	850
Average storage, days [(1)]	35
Dimensions	
Diameter, feet	12
Straight side height, feet	8
Cone height, feet	9

PARAMETER	DESIGN CRITERIA
Soda Ash Feeder	
Quantity	1
Type	Volumetric Screw
Capacity range, pph	9.8 to 98
Control	Automatic and manual start/stop. Automatic and manual speed control with local override.
Soda Ash Solution Tank	
Quantity	1
Type	Vertical Cylindrical
Materials	SS
Capacity range, gal	500
Soda Ash Solution Feed Pumps	
Quantity	2 (1 duty + 1 standby)
Type	Centrifugal
Capacity, gpm	50
Control	Automatic and manual start/stop. Automatic and manual speed control with local override.
Pipe Material	CS
Valve Type	Ball
Notes: 1. Days of storage based on total storage.	

3.5 POLYMER STORAGE AND FEED SYSTEM

A new polymer storage and feed system will be located in the new Operations Building and will include a tote, metering pumps, and appurtenances. Polymer will be fed to Reactor No. 1 and Reactor No. 2 of the high-rate clarifiers. Reference Table 3-5 for design criteria of the new polymer storage and feed system. Reference Figure 3-2 for the new Operations Building plan for the layout of the polymer storage and feed system.

Table 3-5 Polymer Storage & Feed System Design Criteria

PARAMETER	DESIGN CRITERIA
Chemical Information	
Delivered chemical, specific gravity (SG)	35% Active Polymer, SG = 1.02
Feed chemical, specific gravity (SG)	35% Active Polymer, SG = 1.02
Feed points	Reactor No. 1 Reactor No. 2
Plant Water Flow	
Average, MGD	1.2
Maximum, MGD	2
Chemical Dosage as Feed Chemical	
Average, mg/L	1
Maximum, mg/L	1
Chemical Feed Flow as Feed Chemical	
Average, gph	0.14
Maximum, gph	0.24
Polymer Storage	
Type	Tote
Quantity	1
Materials	HDPE
Capacity, gallons, each	330
Total storage, gallons	330
Required storage for 30 days, gallons	101
Average storage, days (1)	98
Dimensions	
Length, feet	4
Width, feet	4
Height, feet	4
Polymer Metering Pumps	
Quantity	3 (2 duty + 1 standby)
Type	Diaphragm
Capacity range, gph (2)	0.01 to 0.24
Turndown ratio, per pump	40:1

PARAMETER	DESIGN CRITERIA
Control	Automatic and manual start/stop. Automatic and manual stroke length and stroke speed control with local override.
Pipe Material	PVC
Valve Type	Ball

Notes:
1. Days of storage based on total storage.
2. Minimum metering pump capacity is based on pump turndown.
3. Future 2 MGD average plant flow will require 170 gallons for 30 days of storage. One 330 gallon tote will be required for the future condition.

3.6 RECARBONATION EQUIPMENT

A recarbonation system is provided to reduce the pH and to form bicarbonate alkalinity to stabilize the softened water, such that the LSI and CCPP values are within the established treated water goals. The recarbonation system will consist of a concrete basin-style contactor with baffles, a carbon dioxide feed system, a carbon dioxide storage tank and appurtenances. The basin will include a mixing chamber with 3 minute retention time. The remainder of the basin will have a minimum of 17 minute retention time for a total retention time of 20 minutes. The feed system and storage tank will be located on an exterior pad adjacent to the contactor basin. Carbon dioxide will be fed as carbonic acid to the feed point. Table 3-6 includes preliminary design criteria for the recarbonation equipment. Reference Figure 3-1 Site Plan for the location of the recarbonation system.

Table 3-6 Recarbonation Equipment Design Criteria

PARAMETER	DESIGN CRITERIA
Carbon Dioxide Contactor	
Quantity	1 x 100%
Rated flow, MGD, each	3.0
Basin type	Concrete basin with baffles
Hydraulic retention time (HRT), min	20
Basin volume, gal	42,600
Basin side water depth, ft	20
Chemical Information	
Delivered chemical, specific volume (SV)	100% CO2, SV = 8.77 ft3/lb (0.11 lb/ft3)
Feed chemical, specific gravity (SG)	100% CO2, SV = 8.77 ft3/lb (0.11 lb/ft3)
Feed point	Recarbonation Basin
Plant Water Flow	
Average, MGD	1.2
Maximum, MGD	2

PARAMETER	DESIGN CRITERIA
Chemical Dosage as Feed Chemical	
Average, mg/L	15.39
Maximum, mg/L	15.39
Chemical Feed Flow as Feed Chemical	
Average, ppd	129
Maximum, ppd	257
CO2 Storage	
Type	Tank
Quantity	1
Materials	SS
Capacity, tons, each	6
Total storage, tons	6
Required storage for 30 days, tons	2
Average storage, days (1)	46
Dimensions	
Length, feet	16
Width, feet	6
Height, feet	6
Carbonic Acid Feeders	
Quantity	2 (1 duty + 1 standby)
Capacity range, ppd(2)	25.7 to 257
Turndown ratio, per pump	10:1
Control	Automatic and manual start/stop.
Pipe Material	CS/PVC
Valve Type	Ball

Notes:
1. Days of storage based on total storage.
2. Minimum feeder capacity is based on feeder turndown.
3. Future 2 MGD average plant flow will require 7,700 lbs for 30 days of storage. One 6 ton tank will be required for the future condition.

3.7 DISINFECTION EQUIPMENT

Primary disinfection will be accomplished through feed of sodium hypochlorite for free chlorine contact. Sodium hypochlorite will be fed to the inlet of the recarbonation process which will be used simultaneously for primary disinfection. Sufficient contact time will be provided in the contactor to achieve 4-log virus inactivation. Following primary disinfection, liquid ammonium sulfate (LAS) will be added to form chloramines for secondary disinfection. The preliminary feed

location for LAS is at the end of the recarbonation basin. The actual location will be determined during final design after input from KDHE. Sodium hypochlorite and LAS storage and feed systems will be located in the new Operations Building and will include totes, metering pumps, and appurtenances. Details for disinfection systems are provided in Table 3-7 and Table 3-8 for sodium hypochlorite and LAS respectively. Reference Figure 3-2 for the new Operations Building plan for the layout of the sodium hypochlorite and LAS storage and feed systems.

Table 3-7 Sodium Hypochlorite Storage & Feed System Design Criteria

PARAMETER	DESIGN CRITERIA
Chemical Information	
Delivered chemical, specific gravity (SG)	12.5% Sodium Hypochlorite, SG = 1.175 (1.04 lbs Cl_2/gallon solution)
Feed chemical, Specific gravity (SG)	12.5% Sodium Hypochlorite, SG = 1.175 (1.04 lbs Cl_2/gallon solution) 10% Sodium Hypochlorite, SG = 1.142 (0.73 lbs Cl_2/gallon solution)
Feed point	Recarbonation Basin (inlet)
Plant Water Flow	
Average, MGD	1.2
Maximum, MGD	2
Chemical Dosage as 100% Chlorine	
Average, mg/L	3
Maximum, mg/L	3
Chemical Feed Flow as 12.5% Sodium Hypochlorite	
Average, gph	1.2
Maximum, gph	2
Chemical feed flow as 10% Sodium Hypochlorite	
Average, gph	1.5
Maximum, gph	2.5
Sodium Hypochlorite Storage	
Type	Tote
Quantity	3
Materials	HDPE
Capacity, gallons, each	330
Total storage, gallons	990
Required storage for 30 days, gallons	865

PARAMETER	DESIGN CRITERIA
Average storage, days [1]	34
Dimensions	
Length, feet	4
Width, feet	4
Height, feet	4
Sodium Hypochlorite Metering Pumps	
Quantity	2 (1 duty + 1 standby)
Type	Tube type peristaltic metering pump
Capacity range, gph [2]	0.03 to 2.5
Turndown ratio, per pump	100:1
Control	Automatic and manual start/stop. Automatic and manual speed control with local override
Pipe Material	CPVC
Valve Type	Vented Ball
Pipe Material in Duct Bank	Teflon Tubing

Notes:
1. Days of storage based on total storage.
2. Minimum metering pump capacity is based on pump turndown. Maximum metering pump capacity is based on feeding 10% sodium hypochlorite due to degradation.
3. Future 2 MGD average plant flow will require 1,450 gallons for 30 days of storage. One 1,600 gallon tank or six 330 gallon totes will be required for the future condition.

Table 3-8 Liquid Ammonium Sulfate Storage & Feed System Design Criteria

PARAMETER	DESIGN CRITERIA
Chemical Information	
Delivered chemical, specific gravity (SG)	40% Liquid Ammonium Sulfate, SG = 1.228
Feed chemical, specific gravity (SG)	40% Liquid Ammonium Sulfate, SG = 1.228
Feed point	Recarbonation Basin (effluent)
Plant Water Flow	
Average, MGD	1.2
Maximum, MGD	2
Chemical Dosage as 100% LAS	
Average, mg/L	3.54

PARAMETER	DESIGN CRITERIA
Maximum, mg/L	3.54
Chemical Feed Flow as Feed Chemical	
Average, gph	0.36
Maximum, gph	0.6
LAS Sulfate Storage	
Type	Tote
Quantity	1
Materials	HDPE
Capacity, gallons, each	330
Total storage, gallons	330
Required storage for 30 days, gallons	260
Average storage, days (1)	38
Dimensions	
Length, feet	4
Width, feet	4
Height, feet	4
LAS Metering Pumps	
Quantity	2 (1 duty + 1 standby)
Type	Tube type peristaltic metering pump
Capacity range, gph (2)	0.006 to 0.6
Turndown ratio, per pump	100:1
Control	Automatic and manual start/stop. Automatic and manual speed control with local override.
Pipe Material	PVC
Valve Type	Ball

Notes:
1. Days of storage based on total storage.
2. Minimum metering pump capacity is based on pump turndown.
3. Future 2 MGD average plant flow will require 433 gallons for 30 days of storage. Two 330 gallon totes will be required for the future condition.

3.8 FILTRATION EQUIPMENT

Gravity filters are located in the new Operations Building downstream of the softening and recarbonation processes to remove any solids remaining in the softened water. To minimize

footprint, packaged dual media filters containing sand and anthracite will be provided, which can operate at a maximum of 4.0 gpm/sf per KDHE Minimum Design Standards. Higher loading rates may be allowed after a period of successful operation. The filters will be equipped with an air-scour blower. A backwash system is required for proper filter operation. Details for the gravity filters are included in Table 3-9. Reference Figure 3-2 for the new Operations Building plan for the layout of the gravity filters.

Table 3-9 Gravity Filter Equipment Design Criteria

PARAMETER	DESIGN CRITERIA
Gravity Filters	
Quantity	3 (2 duty, 1 standby)
Rated flow, MGD, each	1.0
Type	Packaged, dual media, gravity filters
Loading rate, gpm/sf	4.0
Filter area, sf	175
Media	18 inches of 1.0 mm anthracite 12 inches of 0.5 mm sand
Air-scour blower	1 duty, 20 hp
Ancillary equipment	Front piping, valves, instrumentation and controls

A backwash feed pump (1 duty) will be housed in the High Service Pump station, feeding water from the Treated Water Reservoir back to the filters. There will be an emergency interconnection with the high service pumps discharge so that the high service pumps can serve as a backup. The connection will have a flow regulating valve to accommodate the differences in pressure required. After the filter backwash cycle is complete, backwash water will flow by gravity to the Backwash Storage Tank. The Backwash Storage Tank will be a circular concrete tank located below grade. A backwash filter return pumping system will be constructed integral to the tank to send backwash back to the head of the plant at a rate no more than 10% of plant flow. Details for the Backwash system are included in Table 3-10. Reference Figure 3-1 Site Plan for the location of the Backwash Storage Tank and Pump Station and the High Service Pump Station.

Table 3-10 Backwash System Design Criteria

PARAMETER	DESIGN CRITERIA
Backwash Feed Pump	
Quantity	1
Rated flow, MGD	6.3
Type	Vertical turbine
Hp	60
Backwash Storage Tank	
Type	Circular
Volume, gal	84,520

Diameter, ft	27
Depth	20
Backwash Filter Return Pumps	
Quantity	1 duty, 1 standby
Rated flow, MGD, each	0.3 (10% of influent plant flow)
Type	Submersible
Drive	Adjustable frequency drive
Hp	15

3.9 FLUORIDE STORAGE AND FEED SYSTEM

A new fluoride (hydrofluosilicic acid) storage and feed system will be located in the new Operations Building and will include totes, metering pumps, day tank and appurtenances. Fluoride will be fed downstream of the filters prior to the treated water reservoir. Fluoride will be fed for the benefit of dental and skeletal health. Reference Table 3-11 for design criteria of the new fluoride storage and feed system. Reference Figure 3-2 for the new Operations Building plan for the layout of the fluoride storage and feed system.

Table 3-11 Fluoride Storage & Feed System Design Criteria

PARAMETER	DESIGN CRITERIA
Chemical Information	
Delivered chemical, specific gravity (SG)	24% Hydrofluosilicic Acid, SG = 1.211
Feed chemical, specific gravity (SG)	24% Fluorine, SG = 1.211
Feed point	Pre- Treated Water Reservoir
Plant Water Flow	
Average, MGD	1.2
Maximum, MGD	2
Chemical Dosage as Feed Chemical	
Average, mg/L	1.27
Maximum, mg/L	1.27
Chemical Feed Flow as Feed Chemical	
Average, gph	0.22
Maximum, gph	0.37
Fluoride Storage	
Type	Tote
Quantity	1
Materials	HDPE

PARAMETER	DESIGN CRITERIA
Capacity, gallons, each	330
Total storage, gallons	330
Required storage for 30 days, gallons	156
Average storage, days (1)	62
Dimensions	
Length, feet	4
Width, feet	4
Height, feet	4
Fluoride Metering Pumps	
Quantity	2 (1 duty + 1 standby)
Type	Tube type peristaltic metering pump
Capacity range, gph (2)	0.004 to 0.37
Turndown ratio, per pump	100:1
Control	Automatic and manual start/stop. Automatic and manual speed control with local override.
Pipe Material	PVC
Valve Type	Ball

Notes:
1. Days of storage based on total storage.
2. Minimum metering pump capacity is based on pump turndown.
3. Future 2 MGD average plant flow will require 260 gallons for 30 days of storage. One 330 gallon tote will be required for the future condition.

3.10 PHOSPHATE STORAGE AND FEED SYSTEM

A new phosphate storage and feed system will be located in the new Operations Building and will include a tote, metering pumps, and appurtenances. The preliminary location of the phosphate feed will be downstream of the filters prior to the Treated Water Reservoir. Preliminarily, orthophosphate has been used for the basis of design. Final selection of a phosphate chemical (orthophosphate, polyphosphate, or blend) and feed location will be determined during detailed design after discussion with KDHE and, potentially, a pipe loop study. A pipe loop study may be required to determine the dose and type of corrosion inhibitor to protect the distribution system from corrosion. Reference Table 3-12 for design criteria of the new phosphate storage and feed system. Reference Figure 3-2 for the new Operations Building plan for the layout of the phosphate storage and feed system.

Table 3-12 Phosphate Storage & Feed System Design Criteria

PARAMETER	DESIGN CRITERIA
Chemical Information	
Delivered chemical, specific gravity (SG)	100% Zinc Orthophosphate, SG = 1.34
Feed chemical, specific gravity (SG)	100% Zinc Orthophosphate, SG = 1.34
Feed point	Pre- Treated Water Reservoir
Plant Water Flow	
Average, MGD	1.2
Maximum, MGD	2
Chemical Dosage as Feed Chemical	
Average, mg/L	3
Maximum, mg/L	3
Chemical Feed Flow as Feed Chemical	
Average, gph	0.12
Maximum, gph	0.186
Phosphate Storage	
Type	Tote
Quantity	1
Materials	HDPE
Capacity, gallons, each	330
Total storage, gallons	330
Required storage for 30 days, gallons	81
Average storage, days (1)	114
Dimensions	
Length, feet	4
Width, feet	4
Height, feet	4
Phosphate Metering Pumps	
Quantity	2 (1 duty + 1 standby)
Type	Tube type peristaltic metering pump
Capacity range, gph (2)	0.002 to 0.186
Turndown ratio, per pump	100:1

PARAMETER	DESIGN CRITERIA
Control	Automatic and manual start/stop. Automatic and manual speed control with local override.
Pipe Material	PVC
Valve Type	Ball

Notes:
1. Days of storage based on total storage.
2. Minimum metering pump capacity is based on pump turndown.
3. Future 2 MGD average plant flow will require 134 gallons for 30 days of storage. One 330 gallon tote will be required for the future condition.

3.11 TREATED WATER RESERVOIR

A below grade concrete Treated Water Storage Tank will located on the north side of the site. The reservoir will be constructed for ease of expansion in the future. The west end of the basin will be sized with a depth to act as a wetwell for the high service pumps. Reservoir will be designed with stub walls to allow for easier expansion of the tank for future conditions. Reference Table 3-13 for design criteria for the new Treated Water Reservoir. Reference Figure 3-1 Site Plan to see the proposed location for the new Treated Water Reservoir.

Table 3-13 Treated Water Reservoir Design Criteria

PARAMETER	DESIGN CRITERIA
Treated Water Reservoir	
Quantity	1
Type	Baffled concrete basin, below grade
Storage capacity, gal	239,350
Dimensions	
Length, ft	40
Channel width, ft	20
Side water depth, ft	18

3.12 HIGH SERVICE PUMP STATION

A High service Pump station will be located above the Treated Water Reservoir. The west end of the basin will be sized with a depth to act as a wetwell for the high service pumps. Pump station will include 3 pumps for distribution to the north and south service levels (2 duty, 1 standby), a single pump for the Lake of the Forest service area and a backwash feed pump. Reference Table 3-14 for design criteria for the new High Service Pump Station. Pumps will be valved such that the standby pump is available for the north and south service levels and the Lake of the Forest service area. Reference Figure 3-1 Site Plan to see the proposed location for the new high service pump station.

Table 3-14 High Service Pump Station Design Criteria

PARAMETER	DESIGN CRITERIA
High Service Pumps	
Feed Location	South Service Level Storage Tanks
Quantity	3 (2 duty, 1 standby)
Rated flow, MGD, each	1
Min flow, MGD, each	0.3
Type	Vertical turbine
Drive	Adjustable frequency drive
Hp	100
Feed Location	Lake of the Forest
Quantity	1
Rated flow, MGD	0.1
Min flow, MGD	0.04
Type	Vertical turbine
Drive	Adjustable frequency drive
Hp	15

3.13 LIME RESIDUAL TREATMENT FACILITY

A Lime Residual Treatment Facility (LRTF) will be provided for treatment of lime residuals from the high-rate clarification process. The LRTF will allow for percolation of supernatant and landfill or land application for disposal of residuals. Reference Table 3-15 for design criteria for the new LRTF. Reference Figure 3-1 Site Plan to see the proposed location for the new LRTF.

Table 3-15 Lime Residual Treatment Facility Design Criteria

PARAMETER	DESIGN CRITERIA
Lime Residual Treatment Facility	
Quantity	1
Type	Earthen lagoon
Storage capacity, MG (cf)	41.89 (560,000)
Dimensions	
Length, ft	175
Width, ft	160
Depth, ft	20
Storage at 1.5 MGD plant production rate, years	5.2

3.14 SITEWORK AND UTILITIES

3.14.1 Plant Roadways

Access roads to the plant from Swingster Road and around major buildings and structures will be provided. Parking will be provided on the west side of the new Operations Building. An access road will be provided at the new Lime Residual Treatment Facility connecting to existing nearby groundwater well access roads. Pavement will be asphalt. Roads will have two 12-foot travel lanes. Reference Figure 3-1 Site Plan for road work.

3.14.2 Sanitary Drainage

A new sanitary sewer system will be established across the plant to collect sanitary drainage from the new Operations Building. Drainage will be collected for restrooms, sinks, combination eyewash/shower systems and service water hose faucets and floor drains. Chemical storage rooms will not be connected to the sanitary drainage system but will have collection trenches and sumps for removal of any spilled chemicals and washdown water. The Treated Water Reservoir and Backwash Storage Tank will be drained as needed to their respective service feed points and will not be connected to the sanitary drain system. The Recarbonation Basin will be evaluated during design on whether it may be tied directly to the new sanitary system or be drained by pumping. Connection to nearby collection systems will be evaluated during detailed design.

3.14.3 Storm Drainage

A new plant storm water system will be established across the site. Stormwater will be routed and collected to earthen swales with culverts below roadways as necessary. Storm water system design will be based on the City of Bonner Springs requirements. Additional mitigation requirements for stormwater drainage off-site will be evaluated during detailed design.

3.14.4 Potable Water System

Potable water will be fed from the discharge of the high service pumps to establish a plant-wide distribution system. The potable water system will be connected to the Operations Building for fire protection, sinks, bathrooms, wall hydrants etc. Nonpotable services will be located downstream of a backflow preventer. The system will feed fire hydrants (to be located during design) around the site and any yard hydrants necessary for cleaning and maintenance.

3.14.5 Process Piping

Process yard piping between buildings will consist of ductile iron pipe. Chemical systems will be routed through chemical duct banks including carrier pipe and concrete encasement. Where chemical piping is required to be routed above grade, it will be insulated and heat traced to protect from freezing. Piping material will be as defined within the respective chemical paragraphs.

3.14.6 Electricity

A new utility service connection will be required and will be coordinated and provided by the electric utility (Evergy). A backup natural gas generator will be provided for backup power. See Chapter 7 Electrical Design criteria for additional detail.

3.14.7 Natural Gas

Natural gas will be brought to the site for backup power generation purposes. See Chapter 7 Electrical Design criteria for additional detail on the backup power generator. Requirements to connect to nearby gas mains will be evaluated during design.

3.14.8 Lake of the Forest Connection

A new 6-inch PVC interconnection to the Lake of the Forest service area will be required (approximately 9,490 linear feet). The service area will have a dedicated high service pump and tie into the existing distribution system near 8th Street. And Lake Forest Road. Additional evaluation of new pipe size and connection to the existing distribution system will be required during detailed design.

N

60' 30' 0 60' 120'
SCALE 1"=60'

LEGEND:
NEW CONSTRUCTION: ————————
FUTURE CONSTRUCTION: ----------
PIPING/BELOW GRADE: – – – – – – –
FENCE: ———x———

PRELIMINARY - NOT FOR CONSTRUCTION

NO	BY	CHK/APP	DATE	REVISIONS AND RECORD OF USE

BLACK & VEATCH
Black & Veatch Corporation
Kansas City, Missouri

CITY OF BONNER SPRINGS, KANSAS
WATER SUPPLY
AND TREATMENT PLANT STUDY

FACILITY PLAN
SITE PLAN

DESIGNED:
DETAILED:
CHECKED:
APPROVED:
DATE:

0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE

PROJECT NO.
404408

SHEET
OF

Figure 3-1 Site Plan

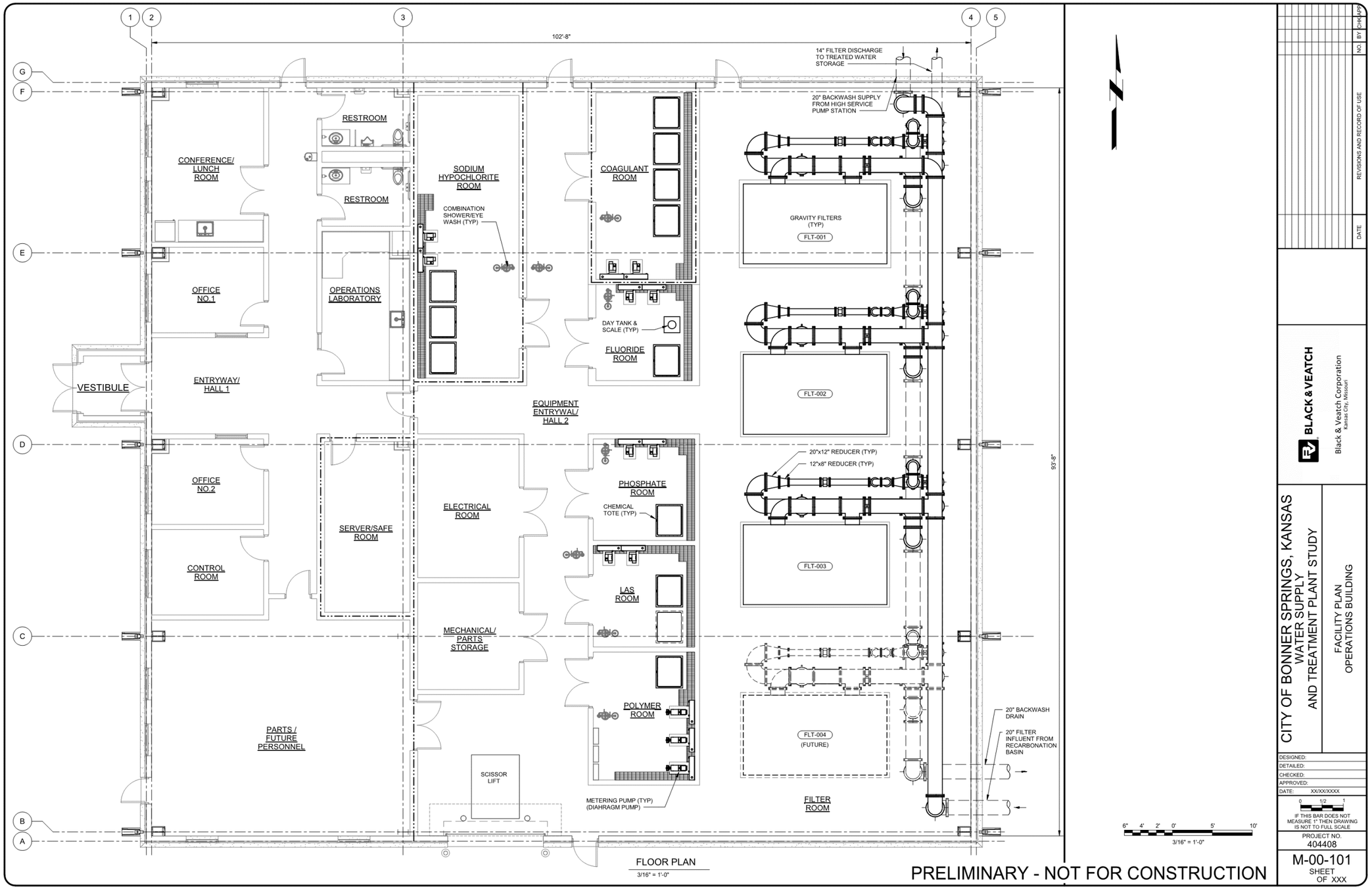


Figure 3-2 Operations Building Layout

4.0 Architectural Design Criteria

4.1 APPLICABLE STANDARDS AND GENERAL REQUIREMENTS

The architectural design will conform to the following codes:

- International Building Code (IBC), 2015 Edition
- International Existing Building Code (IEBC), 2015 Edition
- International Fire Code (IFC), 2015 Edition

The new Operations Building and other facilities at the new Water Treatment Plant will meet the following code requirements of the International Building Code and the International Existing Building Code, respectively:

Table 4-1 Operations Building – Building Code Analysis

OPERATIONS BUILDING	
Occupancy	Mixed Occupancy – Groups F-2 and H-4
Type of Construction	II-B
Allowable Building Area	17,500 SF per story
Actual Building Area	9,880 SF
Allowable Building Height	2 stories (55 ft)
Design Occupant Loads	100 sf/person (industrial) 300 sf/person (electrical & mechanical equipment rooms)
Means of Egress	2 minimum or maximum 75ft travel distance
Accessibility	Administrative areas only. Not required in equipment spaces (IBC 1103.2.9)
Fire Separation	2-Hour fire rated barriers between F-2 and H-4; around Electrical Room; around chemical rooms as required.
Fire Sprinklers	Yes, Sodium Hypochlorite & Coagulant rooms only

4.2 ARCHITECTURAL DESIGN CONSIDERATIONS

The building shell will be a pre-engineered metal building (PEMB). The interior will consist of two areas – a high open process area and an administrative/office area. Chemicals and chemical operations will be separated as required for safety. There will be toilets, breakroom/conference area, offices, and control room. Reference Figure 3-2 for the Operations Building layout.

There will be a server room with fire protection and space to hold personnel for extra protection in the event of a storm. This area will not be designed and constructed as an ICC 500 Storm Shelter.

4.2.1 Wall Construction

Exterior walls will be PEMB pre-finished corrugated metal panel. Insulation will be vinyl faced batt insulation. In process areas, metal liner panel will be installed to a minimum height of 8'-0". In office areas, there will be metal liner panel to the ceiling or painted gypsum wallboard.

For appearance and durability, a masonry wainscot will be used at the exterior base of wall. The aesthetics of the building can be further enhanced by selecting wall, roof, and trim colors for a distinctive look during detailed design.

Interior walls will be concrete masonry units (CMU) covered with paint or coatings appropriate for the use of the room. Certain chemicals will be isolated within fire-rated enclosures. Administrative walls may be furred and covered with painted gypsum wallboard.

4.2.2 Roof Construction

The roof will be PEMB pre-finished corrugated metal panel. Insulation will be vinyl faced batt insulation, exposed on the process side.

4.2.3 Ceiling Construction

The administrative side of the building will have acoustical tile ceilings. Fire-rated rooms will have a concrete ceiling.

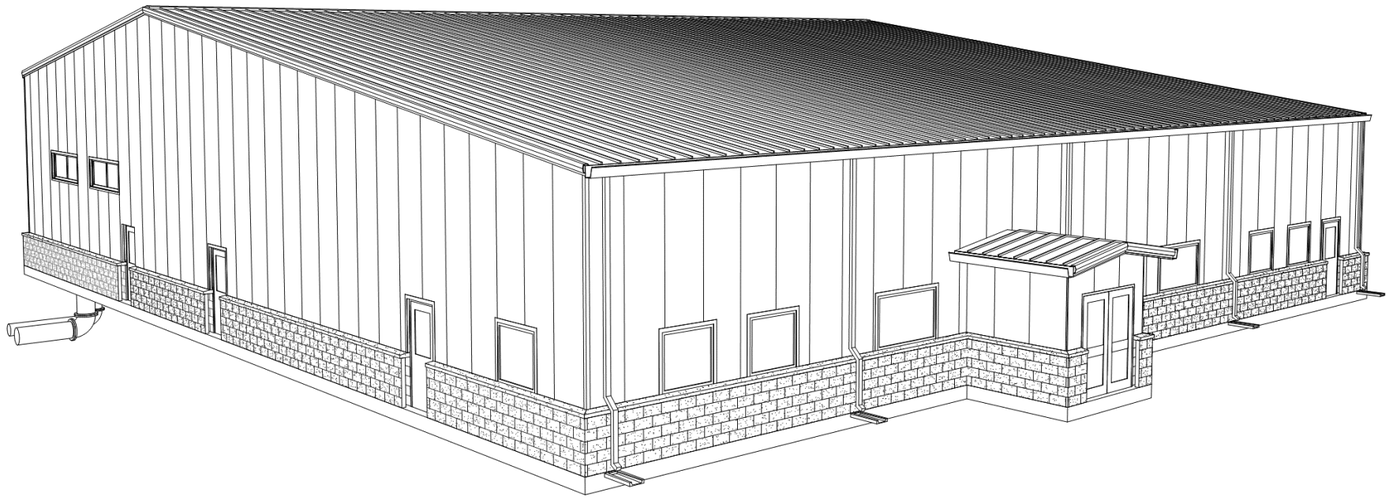
4.2.4 Floor Construction

Flooring will be sealed concrete in the process area; vinyl tile in the breakroom and hallway; ceramic tile in the toilets, carpet in the offices and control room; and anti-static flooring in the server room. Chemical rooms will have a chemical resistant protective coating on the floors and partway up the walls.

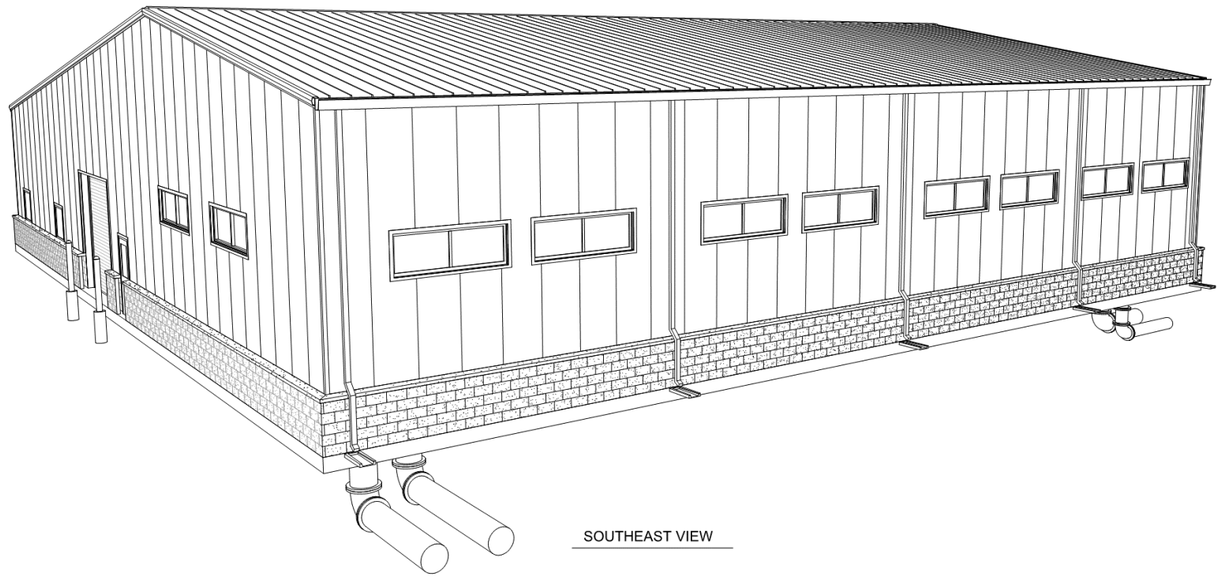
4.2.5 Building Openings

There will be a rolling aluminum door for large equipment and walk doors for personnel. Double doors with an inactive leaf will be used at rooms requiring larger openings for movement of materials. Swinging doors and frames will be FRP.

Administrative areas will have view windows and process areas will have high windows for natural lighting. Glazing will be insulated and low-E.



NORTHWEST VIEW



SOUTHEAST VIEW

PRELIMINARY - NOT FOR CONSTRUCTION

NO	BY	CHK'D	DATE	REVISIONS AND RECORD OF USE

BLACK & VEATCH
Black & Veatch Corporation
Kansas City, Missouri

CITY OF BONNER SPRINGS, KANSAS
WATER SUPPLY
AND TREATMENT PLANT STUDY

FACILITY PLAN
PERSPECTIVES

DESIGNED: DH
DETAILED: TMB
CHECKED:
APPROVED:
DATE: XX/XX/XXXX

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IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE

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SHEET
OF XXX

Figure 4-1 Operations Building Perspectives

5.0 Structural Design Criteria

5.1 GENERAL

This structural design criterion establishes the minimum design requirements for buildings, environmental and liquid containing structures, yard structures, miscellaneous equipment foundations, non-structural components, piping supports, and other miscellaneous items requiring structural design.

5.2 APPLICABLE CODES, STANDARDS, AND REFERENCES

The codes, standards, and references listed below will serve as the basis for structural design.

- International Building Code (IBC), 2015 Edition.
- ASCE 7-10: Minimum Design Loads for Buildings and Structures.
- Preliminary Geotechnical Exploration, Water Supply and Treatment Study, 12401 Kaw Drive, Bonner Springs, Kansas by Geotechnology, Inc.
- ACI 318-14: Building Code Requirements for Structural Concrete.
- ACI 350-06: Code Requirements for Environmental Engineering Concrete Structures and Commentary ACI 350R-06.
- ACI 350.3-06: Seismic Design of Liquid Containing Structures and Commentary ACI 350.3R-06.
- ACI 530-13: Building Code Requirements for Masonry Structures.
- Aluminum Design Manual, 2015 Edition.
- AISC Manual of Steel Construction, 14th Edition.
- AISC 360: Specification for Structural Steel Buildings 2010.
- PCI MNL 120-10: PCI Design Handbook, Precast and Prestressed Concrete, 7th Edition.

5.3 SPECIFIED MATERIAL PROPERTIES

5.3.1 Concrete

- Cast-in-Place Structural Concrete

Flatwork, mortar puddle, and drilled piers:	f'_c = 4,000 psi
Environmental structures:	f'_c = 4,500 psi
Other structures:	f'_c = 4,500 psi

- Prestressed/Precast Structural Concrete: f'c = 5,000 psi
- Nonstructural Concrete (Concrete fill, duct banks, pipe blocking, pipe encasement): f'_c = 3,000 psi

5.3.2 Concrete and Masonry Reinforcement

- Reinforcing Bars (ASTM A615 or ASTM A706): fy = 60,000 psi

- Welded Wire Mesh (ASTM A1064): fy = 70,000 psi

5.3.3 Masonry

- Masonry unit assembly: f'm = 2,500 psi

5.3.4 Structural Steel

- W and WT shapes (ASTM A992, Grade 50): fy = 50,000 psi
- M, S, C and MC shapes (ASTM A36): fy = 36,000 psi
- Angles, bars, plates, and other structural shapes (ASTM A36): fy = 36,000 psi
- HP shapes (ASTM A572, Grade 50): fy = 50,000 psi
- Pipe sections (ASTM A53, Type E or S, Grade B): fy = 35,000 psi
- Round Structural Tube sections (ASTM A500, Grade C): fy = 46,000 psi
- Square and Rectangular Tube sections (ASTM A500, Grade C): fy = 50,000 psi
- Weld materials (ANSI/AWS D1.1, Table 3.1), using E70XX filler metal with minimum tensile strength: Fw = 70 ksi
- High strength bolts (ASTM F3125, Grade A325, Type 1 or Grade F1852 Twist-Off/TC, Type 1) tensile strength: Fu = 120 ksi

5.3.5 Aluminum

- Aluminum Association standard shapes (ASTM B308, Alloy 6061-T6)
- Sheet and Plate (ASTM B209, Alloy 6061-T6)
- Material strengths for all aluminum materials:
  - Tensile yield strength: F_{ty} = 35,000 psi
  - Compressive yield strength: F_{cy} = 35,000 psi
  - Shear yield strength: F_{sy} = 20,000 psi

5.4 LOADING CRITERIA

5.4.1 Dead Loads

Dead load will include the weight of all permanent construction, including roofs, walls, floors, partitions, interior finishes, fixed equipment, tanks and bins including contents, equipment bases, pipes, HVAC ducting, and electrical lighting. Dead load criteria are indicated in Table 5-1.

Table 5-1 Dead Load Criteria

PARAMETER	CRITERIA
Equipment, tanks, silos, etc.	Actual weights
Pipe, 12 inch diameter and smaller	25 psf over full member length
Pipe, 14 inch diameter and larger	Actual weights
Phantom load	2 kips on primary beams, 1 kip on secondary beams, 300 lbs on steel joists
Concrete (normal weight)	150 pcf
Roofing and rigid insulation board	Actual, 15 psf (minimum)
HVAC ductwork (general)	5 psf
Lighting (general)	3 psf

5.4.2 Live Loads (Floor and Roof)

A minimum floor live load of 150 psf will be applicable to all operating floors. For large equipment areas, the combined weight of equipment and concrete pad plus an additional live load of 50 psf over the base area may be used as the live load. The equipment weight may be assumed distributed over an area 3'-0" all around beyond the concrete pad perimeter. Additional live load criteria are indicated in Table 5-2.

Table 5-2 Live Load Criteria

PARAMETER	CRITERIA
Operating floors	150 psf
Walkways, stairs and landings	100 psf
Elevated equipment platforms (non-egress)	60 psf
Storage, general	250 psf
Control room floors	250 psf
Ordinary roof live load	20 psf minimum (no reduction taken)

5.4.3 Snow Loads

Snow loads will be determined in accordance with IBC Section 1608 in conjunction with ASCE 7, Chapter 7. Drifting snow, unbalanced snow and rain-on-snow surcharge will be considered. Basic snow load parameters are given in Table 5-3.

Table 5-3 Snow Load Criteria

PARAMETER	CRITERIA
Minimum Ground Snow Load	20 psf
Terrain Category	C
Importance Factor	1.1
Exposure Factor, C_e	1.0
Thermal Factor, C_t	1.1

5.4.4 Wind Loads

Wind loads will be determined for primary frames and components of structures in accordance with IBC Section 1609 in conjunction with ASCE 7, Chapter 26. ASCE7, Chapter 28 (Wind Loads on Buildings – MWFRS) will be used for low-rise buildings meeting the scope requirements of Section 28.1.1. For other structures, ASCE 7, Chapter 29 (Wind Loads on Other Structures and Building Appurtenances – MWFRS) will apply. ASCE 7, Chapter 30 will be applied to components and cladding. Basic wind load parameters are given in Table 5-4.

Table 5-4 Wind Load Criteria

PARAMETER	CRITERIA
Risk Category	III
Basic Wind Speed	120 mph
Exposure Category	Exposure C

5.4.5 Seismic Loads

Seismic loads will be determined for primary frames and components of building structures in accordance with IBC Section 1613 in conjunction with ASCE 7, Chapter 11. ASCE 7, Chapter 12 will be the basis of design for buildings and similar structures. Non-structural components will be designed for the seismic loads indicated in ASCE 7, Chapter 13. Non-building structures will be designed for the seismic loads indicated in ASCE 7, Chapter 15. Liquid-containing concrete structures will be designed for the seismic loads indicated in ACI 350.3. Interior walls and partitions will be designed for a minimum of 10 psf lateral pressure (strength-level). Basic seismic load parameters are given in Table 5-5.

Table 5-5 Seismic Load Criteria

PARAMETER	CRITERIA
Short period spectral acceleration, (S_s)	0.112
One second period spectral acceleration, (S_1)	0.062
Risk Category	III
Seismic Design Category	B
Structural System Response Coefficient	ASCE 7, Chapter 12
Total Seismic Dead Loads, W	Actual
Site Soil Classification	D

5.4.6 Soil and Backfill Loads

Lateral backfill loadings on walls and below grade structures will be based upon the recommendations of the geotechnical report. Geotechnical load criteria are indicated in Table 5-6.

Table 5-6 Geotechnical Load Criteria

LATERAL EARTH PRESSURES	
• Active earth pressure (drained)	45 pcf
• Active earth pressure (undrained)	86 pcf
• At-rest (drained)	70 pcf
• At-rest (undrained)	99 pcf

A compaction load will be applied at the top of grade for buried walls to account for extra compaction stresses resulting from using mechanical compaction equipment. The compaction loading will be additive to the lateral earth pressure and will be a constant 400 psf decreasing linearly at the rate of the lateral earth pressure until the lateral earth pressure exceeds 400 psf.

Where vehicular truck traffic can come within a horizontal distance from the top of the structure equal to one-half its exposed height, the design will include a live load surcharge pressure equal to 2-feet of earth for an equivalent H20 truck loading. This surcharge is not to be applied concurrently with the compaction load above.

5.4.7 Equipment and Piping Loads

Piping thrust loads will be considered live loads and will be located and sized prior to structural design.

5.4.8 Impact Loads

Structural systems will be designed for impact loads from machinery and other moving items. Impact loads will be determined in accordance with ACI 350.4R and IBC Section 1607.9 for machinery. Weight of machinery and moving loads will be increased as indicated in Table 5-7.

Table 5-7 Machinery and Moving Load Percentage Increase

PARAMETER	PERCENTAGE INCREASE
Elevator loads, and machinery	100%
Light Machinery, Shaft or Motor Driven	20%
Reciprocating Machinery or Power Driven Units	50%
Hangers for Floors and Balconies	33%

5.4.9 Bridge Crane and Monorail Loads

Bridge crane runway beams and monorail beams will be designed for 125 percent of the rated load for each hoist whether powered or manual hoists are used. Lateral and longitudinal forces shall follow ASCE 7, Sections 4.9.4 and 4.9.5 respectively.

5.4.10 Load Combinations

Building structures, components, and cladding will be designed in accordance with the load combinations contained in IBC, Section 1605 or ASCE 7. Reinforced concrete for non environmental structures will be designed using the load combinations in ACI 318, Section 5.3. Reinforced concrete for environmental structures will be designed using load combinations in ACI 350, Section 9.2.

5.5 DESIGN PROCEDURES

5.5.1 Reinforced Concrete Design

Liquid-containing structures, below grade structures in contact with groundwater in normal conditions, and chemical storage structures will be designed in accordance with ACI 350. Other concrete structures will be designed in accordance with IBC Chapter 19 and ACI 318. Concrete will be designed for 4,000 psi strength even when 4,500 psi strength is specified for construction (higher factor of safety).

5.5.2 Reinforced Masonry Design

Concrete masonry will be designed in accordance with IBC Chapter 21 and ACI 530.

5.5.3 Structural Steel Design

Structural steel will be designed in accordance with IBC Chapter 22, AISC Manual of Steel Construction, and AISC 360.

5.5.4 Aluminum Design

Aluminum will be designed in accordance with IBC Chapter 20, and the Aluminum Design Manual.

5.5.5 Geotechnical Design

Geotechnical design will be in accordance with the criteria indicated in Table 5-8, which is obtained from the recommendations of the geotechnical report. Minimum frost depth for soil bearing foundations will be 36 inches.

Table 5-8 Geotechnical Design Criteria

PARAMETER	CRITERIA
Net-allowable soil bearing pressures	1,500-2,500 psf
Modulus of subgrade reaction, slabs-on-grade	Per Geotechnical Report
Allowable passive earth pressure	320-560 pcf
Soil/concrete coefficient of friction	Per Geotechnical Report
Normal groundwater level elevation	Per Geotechnical Report

5.5.6 Flotation

Structures will be designed to resist flotation based on the weight of the structure including weights of fixed equipment and soil above the top surface of the structure. Safety factors will be as indicated in Table 5-9.

Table 5-9 Floatation Safety Factors

PARAMETER	CRITERIA
Normal Operating Condition	1.25
Extreme Maintenance or Flood Condition	1.1

Water retaining basins will be designed for uplift conditions when drained for maintenance. Uplift may be due to flood, groundwater, or perched groundwater (as determined by the geotechnical report) due to surface runoff or basin leakage. Uplift resistance may be obtained by weight of the structure and/or a pumped underdrain system. The uplift resistance system will be designed in conjunction with the geotechnical engineer.

5.5.7 Impact and Vibration Design

Structures supporting large equipment such as pumps and generators will be investigated for the effects of impact and vibration.

5.5.8 Bridge Crane and Monorail Runway Beam Design

The maximum allowed vertical deflection will be L/800 for bridge crane runway beams and L/450 for monorail runway beams.

5.5.9 Non-Structural Component Design

Non-structural components (architectural, electrical, and mechanical) and their anchorage will be designed by the manufacturer for the seismic requirements specified in ASCE 7, Chapter 13, and shop drawings will be required to be sealed by a registered professional engineer when applicable. Components that are exempted from such requirements, per ASCE 7 criteria, will not require a seismic design or any special submittal requirements. Components located outdoors will also be subject to wind, snow, and ice loading requirements as applicable.

5.5.10 Guardrail, Handrail, Ladder, and Stair Designs

Guardrails, handrails, ladders, and metal stair systems will be performance specified and will be designed by the fabricator. Design will comply with the most stringent requirements of the applicable building code, OHSA 29 CFR Part 1926 Subpart R, and all other pertinent OSHA regulations and local safety regulations. Shop drawings, including calculations, will be required to be sealed by a registered professional engineer.

5.6 SPECIAL INSPECTION REQUIREMENTS

Special inspections during construction are to comply with the applicable building code. The Code Required Special Inspections and Procedures specification will be provided to facilitate the special inspections program.

6.0 Mechanical/HVAC Design Criteria

The following is a description of the HVAC systems that will be included on the project.

6.1 GENERAL

This section presents the criteria and basis of mechanical design associated with the plumbing, heating, ventilating, and air conditioning (HVAC) and fire protection systems. The intent of this section is to define the design criterion, establish the minimum design requirements, and describe the mechanical systems. The selection of the systems will be based on operating performance, system efficiency, life safety considerations, long-term durability, redundancy, local representation/service, ease of operation as well as site and specific requirements identified by the designers and the City of Bonner Springs, KS.

6.2 APPLICABLE STANDARDS

In addition to the applicable codes and standards previously identified, the system designs will also be based on, but not limited to, the following publications and standards:

- American Society of Plumbing Engineers (ASPE) Handbooks
- American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbooks and Standards
- Sheet Metal and Air Conditioning Contractor National Association (SMACNA) Handbooks
- National Fire Protection Association Recommended Practices (NFPA) and Manuals
- Occupational Safety and Health Act (OSHA) Standards Manual

6.3 LOCATION & METEROLOGICAL DESIGN CRITERIA

Table 6-1 describes the location and meteorological design criteria.

Table 6-1 Location and Meteorological Design Criteria

CRITERIA	VALUE
Site Elevation, above sea level, ft	1005
Site Location[a]	
Kansas City Intl., MO, USA	
North Latitude, degrees	39.297
West Longitude, degrees	94.731
Ambient Design Temperatures [b]	
Winter, design dry bulb, F	7.5
Summer, design dry bulb/mean coincident wet bulb, F	92.7/76.1
Summer, design wet bulb, F	78.3

CRITERIA	VALUE
Climate Zone	4A
Climate Data	
Mean Daily Dry Bulb Temperature Range, F	18.7
Rainfall Intensity [c]	
Actual, inches/hour	3.75
Design, inches/hour	4.0

[a] The site location is for determining representative weather data for the project site but is not necessarily the specific project location.
[b] The winter and summer design temperatures are based on the ASHRAE frequency levels 1.0 percent and 99.0 percent, respectively.
[c] The actual rainfall intensity rate is based on a 60 minute duration and 100 year return period.

6.4 MATERIALS

Materials will be selected giving preference to those materials that require the least maintenance and have the longest life. These are summarized in Table 6-2.

Table 6-2 Mechanical Systems Materials

SYSTEM	MATERIALS
Sanitary Drainage Systems	Cast Iron, PVC
Water Systems	Copper
Natural Gas Systems	Black steel (above grade), Polyethylene (buried)
Plumbing Fixtures	Vitreous China, Cast Iron, Enameled Steel, Stainless Steel, or Composites
Ductwork	Galvanized steel (Special Coating as required)

6.5 SEISMIC

The seismic design will comply with the "Seismic Design Requirements for Nonstructural Components" of the latest edition of American Society of Civil Engineers Standard ASCE/SEI 7, "Minimum Design Loads for Buildings and Other Structures".

6.6 HEATING AND VENTILATING SYSTEM DESIGN

The following is a description of the HVAC systems that will be included on the project.

6.6.1 Indoor Design Conditions

Table 6-3 describes the indoor design conditions that will be used for the design of the HVAC system.

Table 6-3 Indoor Design Conditions

AREA	DESIGN TEMPERATURES (F) [1]			VENTILATION REQUIREMENTS	VENTILATION NOTES
	SUMMER	WINTER			
	DESIGN	DESIGN	SETPOINT		
Chemical Storage and Process Areas					
Coagulant Storage and Feed Room	103	60	55	1 cfm/sqft (C)	Note 2
Sodium Hypochlorite Storage and Feed Room	103	60	55	1 cfm/sqft (C)	Note 2
Fluoride Storage and Feed Room	103	60	55	6 AC/HR (C)	Note 2
Electrical Room	85	60	55	AC	Note 3
Phosphate Storage and Feed	103	60	55	1 cfm/sqft (C)	Note 2
LAS Storage and Feed Room	103	60	55	1 cfm/sqft (C)	Note 2
Polymer Storage and Feed Room	103	60	55	1 cfm/sqft (C)	Note 2
Gravity Filter Room	103	60	55	1 cfm/sqft (I)	Note 1
Mechanical/Storage	103	60	55	1 cfm/sqft (I)	Note 1
Office Areas					
Offices, Conference Room	75	72	70	AC	Note 3
Parts Storage/Future Personnel	75	72	70	AC	Note 3
Laboratory	75	72	70	AC	
Control Room	75	72	70	AC	Note 3
Server Room	85	60	55	AC	Note 3

[1] Indoor conditions reflect operating temperatures for personnel comfort, code/standard recommendations, or equipment protection.

AC/HR - designates air changes per hour.

(C) - designates the ventilation system operates continuously.

(I) - designates the ventilation system operates intermittently.

AC – designates air conditioning, ventilation provided through AC equipment as required.

Notes:

1. The ventilation system will be sized on the more restrictive of the AC/HR listed or the airflow required to maintain the indoor design temperature based on the summer outside design temperature.
2. Continuous ventilation will be provided at the rate listed. Additional intermittent ventilation will be provided as required to maintain the indoor design temperature based on the summer outside design temperature.
3. The ventilation rate will be based on ventilation or combustion air requirements included in the International Mechanical Code, 2015 edition, or as required for pressurization.

6.6.2 HVAC General Requirements

6.6.2.1 Intakes.

Outdoor air intakes will be designed to manage rain entrainment in accordance with the latest ASHRAE standards. Louvers will be selected to limit water penetration to a maximum of 0.01 oz/ft^2 (3 g/m^2) of louver free area at the maximum intake velocity. Corrosion resistant screens will cover the openings with openings of 1/4 inch (6 mm). Rain hoods will be sized for no more than 500 fpm (2.5 m/s) face velocity with a downward-facing intake such that all air passes vertically upward through a horizontal plane before entering the system.

6.6.2.2 Air Filtration.

Outdoor air will be filtered for areas serving air-conditioned areas. Filtration will consist of 2 inch (50 mm) disposable pleated media filters with a minimum efficiency reporting value (MERV) based on ASHRAE 52.2 guidelines of at least 6.

6.6.2.3 Internal Load Factors.

Heating and cooling loads will be calculated in accordance with ASHRAE Standard 183-2007. Internal heat gains will be included in the calculations based on the following:

- Lighting: 1.3 watts/sq ft (unless otherwise indicated)
- Equipment: Equipment heat loss from equipment anticipated to operate simultaneously

6.6.2.4 Ductwork.

Ductwork will be sized for 0.08 inch water column per 100 feet for a friction loss. Ductwork will be insulated for air conditioning systems, outside air, and heating systems. Insulation will consist of duct liner tested to be resistant to mold growth and erosion under a standardized test method.

6.6.2.5 Outside Air.

Air conditioning and ventilation will be provided in normally occupied areas in accordance with ASHRAE Standards 55 and 62.

6.6.3 Heating Systems

In the Chemical areas, space heating will be provided by either individual electric unit heaters or natural gas unit heaters and will be assessed during design. The heaters will be located to provide uniform space heating of the area served. Each unit heater will be controlled by an adjustable wall mounted thermostat. The electrical and server rooms will be heated with electric unit heaters. The office areas will be heated through natural gas or electric resistance coils within their respective air conditioning equipment. The decision to use electric or natural gas coils will be made during design.

6.6.4 Ventilation Systems

In the Chemical areas, the ventilation systems will consist of continuous and intermittent systems. The continuous ventilation systems serving the Coagulant Storage and Feed Room, Sodium Hypochlorite Storage and Feed Room, Phosphate Storage and Feed, LAS Storage and Feed Room, and Polymer Storage and Feed Room will utilize a common makeup air unit for supply and wall mounted exhaust fans. The makeup air unit will be controlled by a local "ON-OFF" selector switch and each wall mounted exhaust fan will be controlled by a local "ON-OFF-AUTO" selector switch. When each wall mounted exhaust fan selector switch is in the "AUTO" position, the exhaust fan will

be interlocked with the makeup air unit. The makeup air unit will filter and temper the air to the room design temperature before being supplied to the space. A thermostat will modulate the discharge air temperature to the design space temperature.

The continuous ventilation system for the Fluoride Storage and Feed Room will receive makeup air from the common makeup air unit and be exhausted through a corrosion resistant fan and ductwork.

6.6.5 Air Conditioning Systems

The air conditioning systems serving the Office area, Electrical Room, and the Server Room will be split systems consisting of air-cooled condensing units and refrigerant coils installed in air handling units. Air cooled condensing units will be used to reject heat from the refrigerant coils to ambient for the air conditioning systems. The condensing units will be located outdoors.

For the office area unit, outdoor air for ventilation will be introduced and conditioned through the air conditioning unit. Where space positive pressurization is desired or required in the electrical and server rooms, outside air will be introduced and conditioned through the air conditioning unit, or by a separate filtration and pressurization unit. Economizers will be provided in areas where ambient air quality is suitable and economizer controls will be based on enthalpy to control humidity and protect electrical equipment.

6.6.6 Building Control Systems

The HVAC controls will consist of automatic industrial grade electromechanical and electronic controls. Control component enclosures will be selected based on the environment where they are installed. Typical controls will consist of the following:

- Differential pressure indication across supply and exhaust fans designed to operate continuously to indicated fan flow or failure. Where insufficient differential pressure occurs due to limited ductwork, motor current switches will be used.
- Duct mounted smoke detectors where systems have airflows greater than 2000 CFM and are capable of spreading smoke beyond the enclosing walls, floors and ceilings of the room or space in which the smoke is generated.
- Differential pressure gauge and differential pressure switch with alarm across air filters.
- Electric thermostats for control of intermittent ventilation systems to start and stop equipment operation.
- Electric thermostats or electronic sensors to control heating equipment for maintaining the leaving air temperature within the design temperature range.
- Electric thermostats for detection and alarming of low air temperatures.
- Programmable electric thermostats for control of packaged air conditioning systems.

A microprocessor-based standalone system or building automation system (BAS) is not anticipated for the facilities due to the environment and simplicity of the HVAC systems; however, if deemed preferable by the City, a BAS system can be incorporated to replace the electric and electronic controls and provide central monitoring, operation, and management of the HVAC systems.

6.7 PLUMBING DESIGN

6.7.1 Storm Drainage Systems

The primary system serving the Operations Building will consist of gutters and downspouts which will discharge above grade to splash blocks and to a below grade storm drainage system when available and necessary to prevent a nuisance.

6.7.2 Sanitary Drainage Systems

General floor drainage will be provided in the process areas of the Building. Funnel receptors will be located adjacent to equipment with equipment drains. Where practical, receptors will be located to serve multiple equipment drains.

All floor drains, bell-up drains, and plumbing fixtures connected to the sanitary drainage system will be provided with traps and vents. Where individual vents cannot be provided for each trap due to physical constraints, a combination waste and vent system will be utilized for floor drains and funnel receptor drains. All other drains will be individually vented. Piping materials will be cast iron soil pipe with hubless, bell and spigot joints for above grade locations, bell and spigot joints for below grade locations, and PVC schedule 80 for corrosion resistant drainage piping where necessary.

All plumbing fixtures and floor drains located on the floor at or above grade will discharge by gravity to the plant sanitary sewer.

Chemical feed and storage rooms will be provided with containment trenches and will drain to a dry sump within the containment area. A portable sump pump will be used to pump washdown water from the sumps to a bell-up drain. In the event of a chemical spill, the chemical will be pumped to a waste truck for proper disposal.

6.7.3 Water Piping Systems

Potable water from the discharge of the high service pumps will be supplied to the domestic water fixtures and emergency shower/eyewash fixtures. Plant water is drawn downstream of the high service pumps and will be at the distribution system pressure; therefore, no pressure boosting equipment will be required. Where the water pressure exceeds 80 psig, pressure reducing stations will be provided to reduce the water pressure. Water metering equipment will be provided at each building supplied with potable water. Piping materials will consist of soft annealed copper tubing with flared fittings for buried sizes 2 inch and smaller and type K hard drawn copper tubing with solder joint fittings for above grade piping.

All materials in contact with the potable water will comply with the Safe Drinking Water Act of 1986 as amended by the Reduction of Lead in Drinking Water Act of 2011. All plumbing fittings and fixtures intended to convey or dispense water for human consumption will comply with the requirements of NSF/ANSI 61 and NSF/ANSI 372 for low lead.

Protection of the potable water system will be in accordance with local codes or standards. Reduced pressure principle backflow preventers will be provided on the water supply to non-potable water systems. Vacuum breakers will be provided on hose faucets and wall hydrants served by the potable water system when a non-potable water system is not available.

Domestic hot and cold water will be provided to plumbing fixtures as required. An electric water heater and blending valve will be provided in the cold water supply to the emergency shower/eyewash fixtures to permit tepid water temperatures (60°F to 90°F) to be supplied to the fixtures.

Hose faucets will be provided in unfinished areas that may require periodic washdown. Frostproof wall hydrants will be provided at intervals around the exterior of the structures.

6.7.4 Natural Gas Piping Systems

Natural gas for building heat at the Building will be evaluated during design. Piping materials will consist of polyethylene pipe with butt fusion joints for buried sizes 3 inch and larger and socket fusion joints for buried sizes 2 inch and smaller. For above grade and interior locations, pipe will consist of schedule 40 black steel with butt welding fittings for 2-1/2 inch and larger and socket welding or malleable iron fittings for 2 inch and smaller.

6.7.5 Plumbing Fixtures

Plumbing fixtures will be selected for durability and ease of maintenance and housekeeping.

Water heaters in the Operations Building located downstream from a backflow prevention device will be protected by use of an expansion tank.

Emergency shower and eyewash stations will be located in areas where injurious corrosive materials are handled or stored. The emergency fixtures will be located in well lit, highly visible, accessible locations on the same level as the hazard with an obstruction free travel path. The stations will be plumbed to a tepid water supply as described in the water supply piping paragraph, and designed to provide 15 minutes of flow. A floor drain will be located under the emergency shower, unless located in a chemical containment area in which drainage will be routed to the appropriate sump. Each emergency shower and eyewash station will have an alarm device for local and remote alarms. The local alarm will consist of an audible and visible alarm light. Exterior emergency shower and eyewash stations located near loading stations will be freezeproof, through the wall type fixtures.

6.7.6 Building Fire Protection

Fire protection designed to meet the requirements of local codes and applicable NFPA standards will be provided for the Operations Building. Chemical storage rooms of the Operations Building will be protected with an automatic sprinkler system, per local building code, when volume of hazardous chemicals exceed the maximum allowed limit of 500 gallons. The coagulant and sodium hypochlorite chemical rooms will exceed the maximum allowable limits and thus are required to be sprinkler protected. Fire protection will be installed based upon the applicable edition of Codes along with local amendments. Per local building and fire codes, chemical rooms storing coagulant and sodium hypochlorite are classified as group H-4 occupancy.

The following will be used for the building and sprinkler design:

- All hazardous chemical storage areas exceeding maximum allowable quantity limits as allowed by building or fire code will need to be sprinklered.
- Maximum fire flow requirements for the Operations Building is 1,500 gpm for a maximum 2-hour duration-based fire code appendix B adoption.

- Dedicated electrical room and control room will be provided with automatic smoke detection systems and will not be sprinklered.
- Standpipes are not required for the Operations Building due to single story architecture.
- Emergency alarm station and local occupant notification system will be provided for H-4 occupancy rooms.

The following will be used for the fire hydrant and fire water supply design:

- Water supply to fire protection systems will be provided through a new tap to plant potable water distribution pipeline adjacent to the Operations Building. A hydrant flow test will be performed in the vicinity of Operations Building to confirm sufficient flow and pressure is available for fire protection systems. No new pumping units are assumed to be required to boost pressure to meet minimum pressure requirement for building sprinkler systems. The contract documents will include a performance specification for a contractor-designed fire protection system that meets all code requirements.
- The Operations Building will be provided with a hydrant within 400 feet of all portions of the building to be operated by Fire Department during an emergency.
- If needed, new fire hydrants will be provided on the access roads with bollards having sufficient clearance to protect against mechanical damage.
- The farthest hydrant along the fire water main will be sized to provide 1,500 gpm fire flow at minimum 20 psi residual pressure based on the size of the building.
- Water demand for sprinkler system will be approximately 600 gpm at 50 psi residual pressure measured at sprinkler valve station location inside Operations Building.
- The new fire main will be sized to deliver flow and pressure requirements for either fire flow or sprinkler system as listed in this section and designed per NFPA 24.
- Fire pumper trucks will boost the hydrant water pressure to required level using fire truck pump station.
- All control valves on the water supply piping to fire protection system will be electrically monitored by new fire alarm control unit.

7.0 Electrical Design Criteria

This section presents the general electrical design criteria for the electrical power system for the project. The intent is to provide a safe and reliable means of delivering and distributing power while maintaining ease of maintenance as much as possible. The following criterion also addresses several other electrical requirements that are not specifically related to power delivery.

7.1 CODES AND STANDARDS

Electrical design will conform to the latest editions of the following applicable standards and codes:

- National Electrical Code (NEC-NFPA 70), 2011 Edition
- National Electrical Safety Code (NESC)
- Life Safety Code (NFPA-101-AB)
- Standard for Electrical Safety in the Workplace (NFPA 70E)

Standards and codes of the following organizations will also govern where applicable:

- NFPA 820 Fire Protection in Wastewater Treatment & Collection Facilities, 2016 Edition
- American National Standards Institute (ANSI)
- Illuminating Engineers Society (IES)
- Instrument Society of America (ISA)
- National Electrical Manufacturers Association (NEMA)
- Institute of Electrical and Electronic Engineers (IEEE)
- Insulated Cable Engineers Association (ICEA)
- Occupational Safety and Health Act (OSHA)
- American Society for Testing and Materials (ASTM)
- Underwriters Laboratory (UL)

Applicable federal and local codes and UL listing requirements will be followed. Exit signs, emergency egress lighting, and emergency lighting power supply will conform to requirements of the local code authority.

7.2 ELECTRICAL DISTRIBUTION PLANNING

The following section describes an outline of the power distribution system plan.

7.2.1 New Power Distribution

Power for the new treatment plant will come from the new 12.47kV utility service which will be coordinated and provided by the electric utility (Evergy). A new 12470:480V utility transformer will be provided by the electric utility on-site, the anticipated size of the transformer is 500KVA. The utility metering will be on the secondary of the transformer and the utility service will power a service entrance rated 480V motor control center in the electrical room. The new MCC will feed the adjustable frequency drives (AFDs) for the motors as well as the valve actuators and other equipment throughout the facility. The MCC will also feed a 30kVA 120/240V lighting panel for the

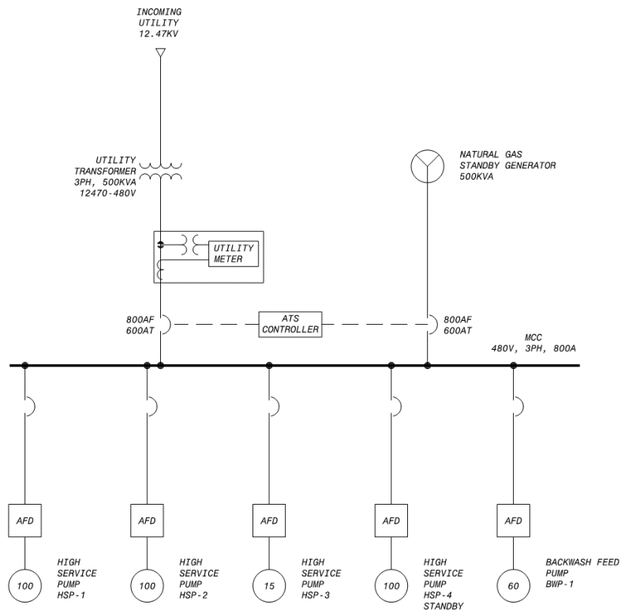
new building along with any miscellaneous loads and a 15kVA 120/240V UPS system to feed the PLC and critical control instruments.

An on-site natural gas engine-generator will provide standby power to the MCC. The engine-generator package will consist of an engine-generator, control panel, cooling system, and accessory items all installed outside in a weather proof enclosure on a concrete base. The standby power feed will connect directly to the MCC. The main breaker and the standby main breaker will be controlled by an automatic transfer controller so there is automatic transition between utility and generator power.

7.2.2 Distribution/Utilization Voltages

The following distribution and equipment utilization voltages and ratings will generally be used. Depending on the specific equipment requirements determined in design, there may be some exceptions to the following numbers:

- Engine Generators 480 volts, three-phase
- Building service 480 volts, three-phase
- Motors, 1/2 to 200 hp 480 volts, three-phase
- Motors, less than 1/2 hp 120 volts, single-phase
- Motor Control 120 volts, single-phase
- Lighting 120 volts, single-phase
- Convenience Outlets 120 volts, single-phase



NOTES

1. ONLY MAJOR EQUIPMENT IS SHOWN (>50 HP). NOT ALL LOADS ARE DEPICTED.

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	BY	CHK	APP	DATE	REVISIONS AND RECORD OF USE
####	####	####	####	####	#### #### #### ####

BLACK & VEATCH

Black & Veatch Corporation
Kansas City, Missouri

CITY OF BONNER SPRINGS, KANSAS
WATER SUPPLY
AND TREATMENT PLANT STUDY

FACILITY PLAN
POWER DISTRIBUTION FUNCTIONAL DIAGRAM

DESIGNED:
DETAILED:
CHECKED:
APPROVED:
DATE:

0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE

PROJECT NO.
404408

SHEET
OF

Figure 7-1 Power Distribution Functional Diagram

7.3 GENERAL ELECTRICAL CRITERIA

The following criteria identify the general requirements and guidelines to be used for the electrical power equipment and support systems in the electrical design.

7.3.1 480 Volt Switchboard

The incoming power from the outdoor utility transformer will go through a 480V switchboard section housing the utility meter. The switchboard will be service entrance rated.

7.3.2 480 Volt Motor Control Center and Starters

Indoor, class II, type B wiring Motor Control Centers will be used in areas that will contain multiple motors. Supply circuit to Motor Control Centers will be 480 volts, 3-phase, 3-wire. Motor Control Centers will have copper phase buses and a copper ground bus. Motor Control Centers will be 20 inches deep. Some spares and spaces will be allowed (on the order of 10 percent spares and 10 percent spaces) in addition to the identifiable spares required for known future equipment. Transient voltage surge suppressors will be provided integral to each Motor Control Center assembly.

The MCC will be rated to handle short circuit currents equal to or in excess of the available fault current. The MCC main breakers will be a molded case type with solid-state trip unit with long-time (L), short-time (S), instantaneous (I), and ground-fault (G) protection functions. Distribution breakers on the MCCs will be molded case type with solid-state or thermal magnetic trip units. MCCs will measure 20 inches deep. Some spares and spaces will be allotted (on the order of five percent spares and ten percent spaces).

Except for packaged and HVAC equipment, motor starters will generally be located within a Motor Control Center. Starters will include a green indicating lamp for RUNNING, a red indicating lamp for OFF, and an amber indicating lamp for trouble or failure (where applicable). All indicating lights will be LED type.

7.3.3 Motors and Adjustable Frequency Drives

Motors will be specified with high efficiency ratings. Motor enclosures will be suitable for the environment in which they are installed.

All motors will be provided without integral space heaters.

Motors 50 horsepower and above will have adjustable frequency drives. Additionally, motors that need variable pumping outputs will have adjustable frequency drives.

7.3.4 Panelboards

Power distribution panelboards or power centers will be 480Y-volt, three-phase, three-wire type with a main circuit breaker.

Lighting panelboards will be 240/120 volt single-phase with the main circuit breaker sized to match the lighting transformer capacity.

Each panelboard will have a minimum of 20 percent spare breakers with spaces, bus work, and terminations to complete the standard size panelboard. Transient voltage surge suppressors will be provided integral to each panel assembly.

7.3.5 Convenience Receptacles

Convenience receptacles for general service will be located on the surface of walls or columns. Provisions for receptacles at all air conditioning units and air handling units will be made as required by NEC.

Convenience receptacles will generally be mounted 18 inches above floors, except convenience receptacles outdoors or in rooms where equipment may be hosed down will be mounted 48-inches above the floor or grade.

Weatherproof receptacles will be utilized outdoors, in chemical feed and storage areas, and in wet and damp locations. Receptacles installed outdoors will be provided with ground fault circuit interrupting capability.

7.3.6 Raceways

Specific types of raceway will be chosen for use in various locations in the facility based on moisture, temperature, and exposure to damage, corrosion, voltage, and cost. An underground duct bank consisting of concrete encased PVC conduits will be provided for most circuits that are routed outside of buildings on the site. Duct banks will include spare conduits. The following systems will be separately grouped in duct banks:

- Power and discrete control wiring below 600 volts.
- Adjustable frequency drive power circuits will be in steel conduit.
- Process instrumentation analog and communication wiring, including 24 volt discrete signals, intrinsically safe circuits, and LAN/Data Highway computer circuits.

The following general guidelines will be used for raceway sizing, selection, and installation:

- Conduit will be sized based on XHHW-2 insulation for all conductors 600 volts and below.
- The minimum diameter of exposed conduit in all areas will be 3/4 inch.
- Raceways in duct banks will generally not be smaller than 2 inches.
- Raceways in walls and ceilings of control rooms, offices, and all areas with finished interiors will be concealed.
- The number of conduit bends will be limited to an equivalent of 270 degrees on long runs.
- Exterior, exposed conduit will be PVC coated rigid galvanized steel. The use of this type of conduit will be limited to required areas only.
- Exterior, underground, direct buried and concrete-encased conduit will be PVC Schedule 40.
- Concrete encasement within 15 feet of building entrances, under and within 5 feet of roadways, and within 10 feet of indicated future excavations will be reinforced.
- Interior, exposed conduit will be Rigid Galvanized Steel (RGS).
- PVC Schedule 80 conduit will be used for corrosive chemical areas.
- Interior, concealed conduit will be PVC Schedule 40.

7.3.7 Cable

All lighting, power, and control wiring rated 600 volts and below will use stranded copper conductors with THHN - THWN insulation. Individual No. 14 AWG conductors will be used for discrete control circuits, unless it is practical to use multi-conductor cables to group control circuits. Cables will have 600V insulation.

Twisted-shielded pair control cable with 16 AWG individual stranded copper conductors, PVC insulation, and an aluminum mylar tape shield around the pair will be used for analog signals. Multi-pair cables will be used where grouping of circuits is practical. Cables will have 600V insulation.

7.3.8 Grounding and Lightning Protection

The electrical system and equipment will be grounded in compliance with the NFPA National Electrical Code (NEC). Conductors will be No. 4/0 AWG copper, minimum, for interconnecting ground rods and for connections to transformers and MCCs. A grounding ring will be provided around all new buildings and major structures. Electrical equipment, devices, panelboards, and metallic raceways that do not carry current will be connected to the ground conductors. Transformer neutrals of wye-connected transformers will be solidly grounded through a grounding conductor connected to the grounding system.

A ground wire will be installed in all raceways that contain power conductors at any voltage.

A lightning risk factor calculation will be completed for the project. If the calculated risk of lightning strike is substantial, lightning protection systems meeting the requirements of NFPA 780, Standard for Lightning Protection Systems, will be provided for the appropriate buildings or structures.

7.3.9 Lighting Requirements

Exterior lighting will be provided for all new structures at the WTP. Exterior and indoor light fixtures will be LED type fixtures.

Lighting levels in the facilities will be provided following the recommended levels as suggested in the Illumination Engineering Society (IES) handbook. LED types of light fixtures will be used for all areas.

In general, the following suggested foot candle levels will be the target levels for design. Actual levels provided will be further evaluated in detailed design. Suggested levels are:

Table 7-1 Targeted Design Foot-Candle Levels

AREA	FOOT CANDLE
Electrical Rooms	35
Control Rooms	30
Conference Rooms	40
General Site	1
Lunchrooms	35
Laboratories	75
Maintenance Areas	50
Office	70
Process, outside	5
Process, inside	30
Storage	15
Walkway	5

7.3.10 Fire Alarm Systems

Fire alarm systems will be installed as required in new buildings. Where required, smoke detectors, sprinkler flow switches, ventilation flow switches, combustible gas detectors, heat detectors, audible and visual alarms, and manual fire stations will be connected to a central fire alarm control panel, as required. Partial design of the fire protection system will adhere to local building code requirements. Final design of fire alarm system will be via performance specification in the contract. Contractor will be required to procure the service of a local fire alarm system supplier who will be responsible for determining all local fire code requirements and submitting a complete design which complies with those requirements.

7.3.11 Security System

Security system equipment will be included in new buildings on the plant site. At a minimum, magnetic door contacts, which signal an exterior door has been opened, will be connected to the plant control system PLC. Provisions for connections to remote locations will be provided as required and as determined in final design.

Input on additional security requirements will be required by the City prior to the completion of the final design phase. Examples of advanced security features may include electronic building and site access or motion detectors. The specific type and level of security protection will need to be coordinated with the City based on their needs at the Bonner Springs Water Treatment Plant.

7.3.12 Load Study/Short Circuit/Voltage Drop Analysis/Coordination Study

A load analysis will be prepared during final design to help plan the power distribution system. Major loads, including the estimated value of connected loads and peak running loads will be

calculated. Redundant and standby units will be excluded from the total connected load to establish the critical running load requirements.

A preliminary short circuit analysis will be prepared during the final design phase to properly specify the equipment in the power distribution system. A short circuit current calculation along with a protective device analysis will be required to be submitted by the contractor during the construction phase. The contractor will be required to submit final short circuit and coordination study documents and data in paper form and in PDF electronic file form on CD-ROM for delivery to the Engineer and Owner during construction and prior to electrical start-up.

7.3.13 Arc Flash Hazard Analysis/Short Circuit Study/Coordination

During the construction phase of the project, an arc flash hazard analysis will be specified to be commissioned by the contractor. The analysis will cover all pieces of electrical equipment in accordance with OSHA 29 CFR Part 1910, NEC, NFPA 70E, and IEEE 1584. The arc flash analysis will be performed in coordination with the short circuit and coordination studies. Arc flash study results will be used to properly label all electrical equipment as to the severity of the arc flash hazard and the minimum personal (PPE) required to perform work on each piece of energized equipment.

8.0 Instrumentation and Controls (I&C) Design Criteria

The Instrumentation and Controls (I&C) System for the City of Bonner Springs, KS Water Treatment Plant, referred to as the Plant Control System (PCS), will focus on efficient and reliable monitoring and control of equipment and processes. All I&C work will be in accordance with local and state codes, the criteria outlined in this section, other requirements applicable to the I&C design of a water treatment facility and City's system objectives. A control block diagram illustrating proposed PCS components is provided as part of this Report as Figure 8-1.

8.1 CODES AND STANDARDS

All I&C work will adhere to the latest editions of the following applicable standards and codes:

- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- Insulated Cable Engineers Association (ICEA)
- Institute of Electrical and Electronics Engineers (IEEE)
- International Society of Automation (ISA)
- National Electric Code (NEC)
- National Electrical Manufacturers Association (NEMA)
- National Fire Protection Association (NFPA)
- Occupational Safety and Health Administration (OSHA)
- Underwriters Laboratories (UL)

Applicable federal and local codes and UL listing requirements will be followed. All electrical equipment, conduit, and wiring will be UL listed.

8.2 INSTRUMENTATION AND CONTROL REQUIREMENTS

The I&C system design will adhere to Black & Veatch engineering standards and industry best practices except when accommodating any of the City's standards or preferences. Instrumentation and control devices will be based on standard Black & Veatch specifications, except where specific models or types of devices are requested by the City.

8.3 INSTRUMENTATION AND I/O SIGNAL STANDARDS

Analog field instrumentation will utilize 4-20 mA DC signals to/from the programmable logic controller (PLC). Four-wire instruments will be powered by 120 volts AC. Discrete PLC input and output (I/O) signals will utilize 120 volt AC signals to and from the PLC.

Where a software network is available, network devices will communicate over an Ethernet-based protocol.

8.4 PLANT CONTROL SYSTEM

The proposed PCS will consist of a PLC based control system with a Supervisory Control And Data Acquisition (SCADA) system front end to provide efficient and reliable monitoring and control of plant equipment and processes. The PLC-based control system will be designed in a distributed

configuration, with PLCs installed at various locations across the new treatment plant. Each PLC enclosure will monitor and control field instrumentation, equipment, and vendor packaged systems via hardwired I/O signals or via a digital communication network. All instrumentation and equipment interfacing with the various PLCs will be made available to the SCADA system, allowing facility processes to be monitored and controlled by operators from Human-Machine Interface (HMI) workstations.

Control system equipment will be selected and standardized to maintain system reliability, improve ease of use, and to facilitate maintenance activities. The PLCs will provide a means of controlling plant equipment and processes and will provide adequate alarming and monitoring to ensure a safe shutdown of systems should a failure or alarm condition occur. The control system will be programmed to provide an appropriate level of automation for the controlled process and will operate without dependence on continuous operator input. Manual hardwired controls, with local/remote switching capability, will be provided at the field device level near controlled equipment to allow continued operation of critical system processes regardless of control system operational status. Field instrumentation and panel mounted devices allow for system performance to be monitored and field verified independently of the control system.

The WTP will be monitored and controlled through a SCADA software platform. The SCADA software will be fully featured and will handle all HMI, historical data logging, trending, alarming, and reporting functionality. Various industry standard SCADA software solutions providing this functionality include Wonderware InTouch and System Platform, Rockwell FactoryTalk, GE iFIX, Trihedral VTScada and Inductive Automation Ignition. The SCADA software will be further evaluated during detailed design to select a solution that will meet the City's required features and any expandability and accessibility requirements. If the City intends to receive continued PCS support from a third-party system integrator, the integrator's familiarity with the SCADA software be considered in order to facilitate any support services.

The SCADA and PLC software will be fully installed, configured, and tested by a subcontracted system integrator. The PCS will incorporate new plant equipment and processes and provide any remote control functionality. Process graphics, alarms, status information, trending, reporting, and historical database points will be configured for the new SCADA system as a part of this project. All processing will occur at the PLC level. The HMI will issue any setpoints, parameters, and commands to the PLC where the PLC will then execute any control algorithms and control equipment. Any processing at the workstation or server computer will not disrupt plant control.

8.4.1 Programmable Logic Controllers

The PCS will consist of multiple PLCs distributed across the new WTP. Conceptual design assumes the following:

Table 8-1 Preliminary PLC Locations

PLC DESCRIPTION	LOCATION	SERVICE
Process PLC	Server/Safe Room (Operations Building)	Plant Influent, Filtration, Softening Equipment, Recarbonation, Backwash Recovery Pumps, Backup Power Generator
Chemical Feed PLC	Server/Safe Room (Operations Building)	Chemical Metering
HSPS (High Service Pump Station) PLC	High Service Pump Station	HSPS Pumps, Backwash Supply Pumps, Flow Control

PLCs will interface with equipment – including adjustable frequency drives, motor control centers, and local control panels – and instrumentation at the treatment facility. The PLCs will gather process and performance information from the equipment and instrumentation and execute control strategies. A subcontractor, regularly engaged in system integration, will provide, install, and program the various PLCs. The PLCs will be an industrial-type, rack-based, modular, microprocessor-based system allowing for I/O and communication requirements to be selected and scaled according to process requirements. Industry standard PLCs, such as those manufactured by Allen-Bradley, GE, Schneider Electric/Modicon, or Siemens will be provided. Specific models will be refined as control requirements are determined during detailed design phases.

The Contractor will provide and install enclosures at specified locations to house PLC equipment and to terminate any field I/O or PLC communication cabling. PLC enclosures will be installed in locations with a high density of monitored and controlled equipment and instrumentation in order to minimize wiring requirements and to consolidate control hardware. The PLCs will communicate with the SCADA system and any other networked equipment via an Ethernet-based communication network. PLC communication media will be a combination of fiber optic and CAT 6 cable. The enclosures will be installed complete with a managed Ethernet switch and with any additional panel appurtenances, including but not limited to, interposing relays, terminal strips, power distribution equipment, and surge suppression hardware. The enclosures will also be furnished with an uninterruptible power supply (UPS) and redundant control power supplies. Power supply failures and UPS alarms will be alarmed at the HMI.

PLC design will account for known future equipment and will be sized for future expansion. Special consideration will be given to the distribution of I/O points across a PLC's modules to minimize the amount of equipment affected by a module failure. Communication modules at each enclosure will be compatible with an Ethernet-based network. All I/O and communication modules and any other pertinent PLC accessories will be of the same manufacturer to minimize compatibility issues.

Where practicable, PLC enclosures will also serve as the local control panel for any non-packaged equipment. Where additional controls are required beyond local actuator or packaged equipment controls, any indicating lights, switches, pushbuttons, operator interface terminals (OITs), or alarm devices will be centrally located on the nearest PLC enclosure. If the final location of an enclosure is not conducive to an operator's ability to supervise the controlled equipment, an additional local control panel may be provided.

8.4.2 Plant Network

The rack-style network enclosure will be provided and installed in the Server/Safe room to house the following network equipment:

- Redundant PLC/SCADA Network Switch
- Administrative/Corporate Network Switch
- Security Network Switch
- Redundant PCS I/O Servers
- Historian Server
- Authentication Server
- Fiber optic and metallic twisted pair Ethernet cable patch panels
- Network Firewall
- Uninterruptible Power Supply

The plant network architecture will consist of an Ethernet-based Local Area Network (LAN). Within building envelopes, CAT 6 cable will be used for digital network communication. Shielded twisted pair Ethernet cable will be used when routing cable through process areas. Fiber optic cabling will be used outside of building envelopes or where networked device locations exceed the recommended maximum Ethernet twisted-pair cabling distance. PLC and SCADA traffic will utilize the same physical network cabling and hardware and all traffic will be routed through the PLC/SCADA network switch. Any administrative traffic and Internet Protocol (IP) security camera network traffic will be routed through their respective switches on separate cabling.

If network hardware is shared by multiple networks, the networks will be segmented at the Data Link layer by configuring separate Virtual Local Area Networks (VLAN) for each type of traffic. In addition to VLAN segregation, network IP addressing will be logically separated by implementing structured subnet groups. All network cabling and hardware will support a minimum of 100BaseTX/100BaseFX duplex Ethernet networks. All network equipment will be provided, installed and configured by the Contractor as a part of this project. All network hardware will be powered by an uninterruptible power supply and redundant power supplies. Additionally, network communication status will be monitored at all times. Disruption of any network communication will be alarmed at the HMI.

In order to support administrative functions such as email, web-browsing, and Voice-over-IP (VoIP), a broadband Internet service plan may be required. The existing administrative / maintenance building at the current water treatment plant may already have an existing Internet connection. This interconnection will be further evaluated during detailed design phases. If possible, the existing Internet connection will be reutilized.

8.4.3 Computer Control System

The WTP Operations Building will feature a control room. Two operator HMI workstations and an engineering workstation will be installed in the control room, allowing City personnel to monitor and control facility equipment and processes from an on-site location. Each HMI workstation will be configured with the same SCADA application to maintain operational consistency. The two workstations will provide redundancy in the event of a workstation failure. The engineering workstation will be loaded with a full development version of the SCADA software and used to

configure graphics, test and deploy operating system and anti-malware updates and patches, To improve system security, the HMI will require a user-specific password log-in and be configured with administrative control levels based on user privileges. Inactive sessions will timeout after a predefined time period to prevent unintended access from an unsupervised workstation.

The WTP SCADA software will operate on redundant PCS I/O servers installed in a network rack in the Server/Safe room. The server will be a rack-mounted server-class computer running on a Microsoft operating system. The servers will be equipped with multi-core processors and sufficient memory and storage to support PCS requirements. The PCS I/O servers will communicate with PLCs over the plant network and update the HMIs with process and equipment information and alarms. The redundant PCS I/O servers will handle all I/O server functionality, terminal services. Historian services and any user authentication features will be handled by separate dedicated servers.

Additional control room equipment requirements such as furniture, monitors, printers, or IP phones will be elicited from the City during detailed design phases.

In addition to workstations located in the control room, a workstation will be provided in the Operation Building Laboratory. The workstation will interface with the SCADA system or any external servers as required by the City.

The City has expressed an interest in the ability to access the PCS remotely. It is anticipated that the site may not be staffed at all times. Accordingly, remote access to the PCS HMI, trending, historian, reporting, and alarming features must be available to provide the City with the ability to continuously monitor and control the facility. Various SCADA software platforms feature remote access solutions. As an alternative, an encrypted virtual private network (VPN) connection may allow plant personnel to access any required PCS functions through a dedicated PCS laptop. PCS security will be evaluated based on the City's remote access requirements.

8.4.4 Security

To improve site security, security cameras, intrusion alarms, and access control will be implemented across the facility. Exterior doors will require card access and will be equipped with intrusion/proximity switches.

Security cameras will be installed at locations across the water treatment plant and will be accessible from the control room. Where practical, IP security cameras will be provided and powered over their network interface (PoE, Power over Ethernet) according to IEEE 802.3af/at standards to minimize power cabling requirements.

8.4.5 Existing/Vendor Systems

The PCS will be designed to interface with both existing and vendor systems. The current water treatment plant utilizes radio telemetry to communicate with remote wells, storage tanks, and booster pump stations. Radio telemetry equipment condition will be verified during detailed design phases to determine its suitability for use at the new water treatment plant. If the telemetry equipment is in an acceptable condition and meets PCS interconnection requirements, it will be reutilized to incorporate telemetry information from remote facilities. If these criteria are not met, telemetry equipment will be replaced with an equivalent device to the extent possible in order to minimize telemetry configuration requirements.

In the case of vendor systems, status and alarm information will be monitored by the PLC and relayed to the HMI. Any required signals will be incorporated into the PCS for controlling vendor equipment. Equipment may include packaged process equipment, fire protection equipment, and backup power generators. Where possible, communication with networked packaged equipment will use an Ethernet-based network to minimize protocol compatibility issues.

Fire alarm and detection system will be provided as indicated in the Fire Alarm Systems section. The Fire Alarm System components will be interconnected as required for alarming at the HMI.

8.4.6 System Configuration

Configuration of the PCS will be the responsibility of the Contractor through the use of a local system integrator. This will include the configuration of the servers, workstations, PLCs, operator interface terminals (OITs), and HMIs. The configuration also includes graphic display development, system database and reports. Standards will be developed with the City and documented during detailed design and construction phases.

8.4.7 Instrumentation

Plant instrumentation is provided to support monitoring and control of the process and equipment systems. Additional instrumentation is provided to alarm abnormal system operation or safety hazard conditions. Where possible, instruments will be microprocessor based 'smart' instruments, which can be calibrated and maintained through a digital interface. Instrumentation will be based on standard Black & Veatch specifications, except where specific models are requested by the City.

All instruments, switches, and control sensors are to be rated for the environment in which they will be located. In general, devices mounted indoors (air conditioned & non-air conditioned) shall be NEMA 12 rated. Devices mounted outdoors or in wet or corrosive environments (indoors or outdoors) will be NEMA 4X rated.

All wetted materials need to be chemically compatible with the process fluid. For highly corrosive process applications, diaphragm seals or annular seals shall be provided as indicated on the Contract Drawings. All diaphragm and annular seals are to be factory sealed with fill fluid as designated by the contract documents. No field assembly of diaphragm seals or annular seals shall be done except by a factory trained technician.

All instruments are to be industrial grade with UL, FM, or equivalent listing for the installation environment.

Flow Instrumentation

It is currently anticipated that magnetic type flow meters will be used for liquid flow measurement in full pipe applications. Magnetic type flow meters are a proven technology widely used in water and wastewater facilities. Thermal mass flow meters will be used for air and gas flow measurements. Flow switches will be provided for emergency showers and eyewash stations.

Level Instrumentation

Level measurement technology for enclosed tanks is expected to be flange-mounted pressure sensing level transmitters. Enclosed tanks containing harsh chemicals will utilize non-contacting ultrasonic type level instruments. Level measurement technology for basins or holding tanks where foaming is anticipated will be radar type or submersible pressure probe level instruments, while basins with no foaming will utilize ultrasonic type level instruments. Scales will be used to measure chemical tote levels.

Pressure Instrumentation

Pressure instrumentation consisting of digital pressure transmitters, dial-type gauges, and switches will be provided for monitoring equipment and process variables and to provide equipment protection. Digital pressure transmitters will utilize diaphragms to isolate the pressure element from process fluid. Pressure elements will be mounted to 3-way valve manifolds for calibration, testing, and mounting of dial-type pressure gauges.

Analytical Instrumentation

Analyzers will be used to measure water quality of process fluids and air quality of process spaces. Analyzers are available in a variety of form factors such as offline sample systems, pipe insertion probes, or channel insertion probes. Preferred form factors will be pipe insertion probes or channel insertion probes, but the form factor will ultimately be selected based on accuracy required for the process. All analyzer instruments will be manufactured by the same company where possible. Chlorine residual and pH analyzers are anticipated to be implemented measure process quality.

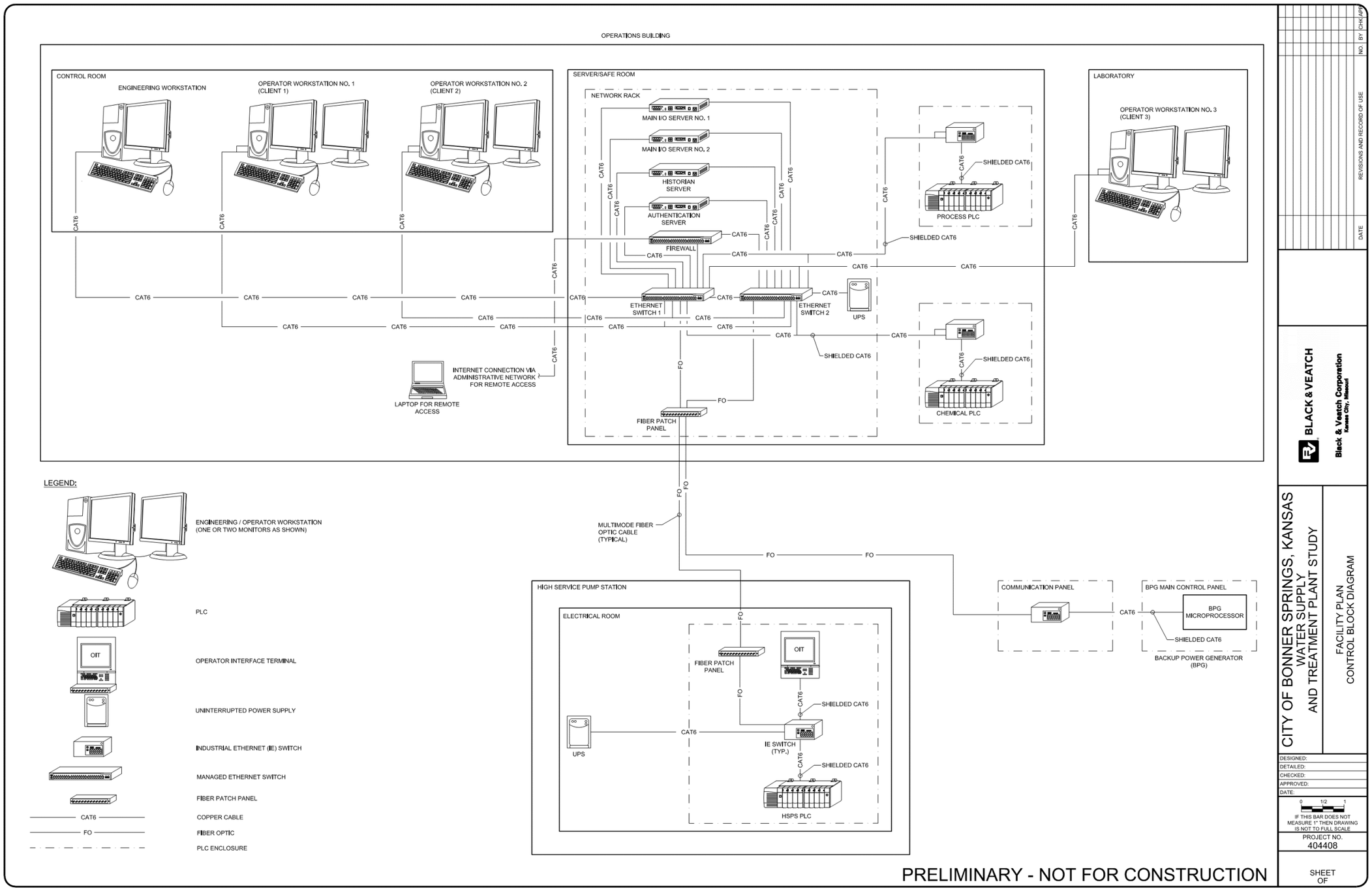


Figure 8-1 Control Block Diagram

8.5 CONTROL SYSTEM DESIGN STANDARDS

8.5.1 P&ID Drawings

P&IDs to be developed during detailed design phases will include all major processes associated with the new facility. Drawing format will follow Black & Veatch standard drawing procedures. Drawings will be schematic in nature. The tagging convention used on P&ID drawings will be based on the ANSI/ISA-5.1-2009 standard as indicated in the following section.

8.5.2 Equipment Tagging Convention

An equipment tagging convention will be used to designate all major equipment and process instrumentation included in this project. Equipment tags will consist of letter designations to describe the System Code and Function Code followed by a three digit Sequence Code. In general, the tagging convention will follow ANSI/ISA-5.1-2009 Instrumentation Symbols and Identification standards.

Equipment tag structure is summarized in the figure below:

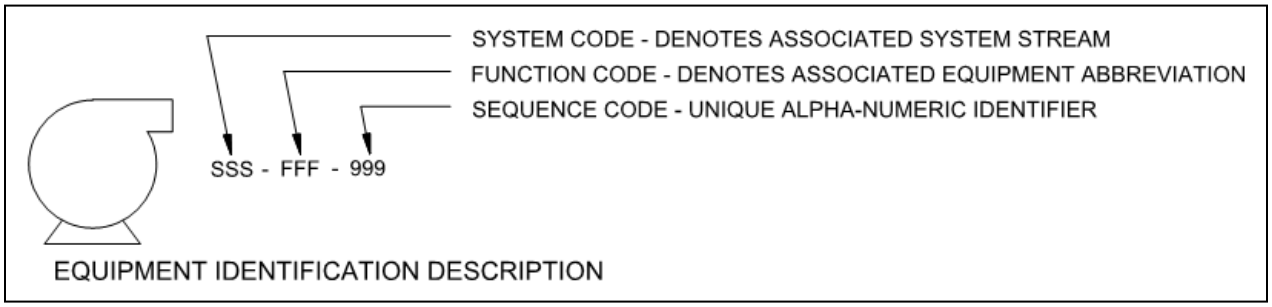


Figure 8-2 Equipment Tagging Convention

System Code – System Codes are abbreviations of the processes and systems involved in the project. Processes include treatment systems, chemical feed systems, pumping systems, and storage systems.

Function Code – Function Codes describe the type of equipment or its function. This code consists of a series of 1 to 4 letters that abbreviate the specific equipment function or type. Designations generally follow ANSI/ISA-5.1-2009.

Sequence Code – Sequence Codes are three digit numbers providing a unique identifier such that equipment that may have the same System Code and Function Code can be distinguished.

8.6 CONTROL MODES

In general, the equipment at the water treatment plant will be operated in one or more of the following control modes:

- **Local Manual**: The equipment is manually controlled from an Adjustable Frequency Drive (AFD), Motor Control Center (MCC), local control panel, or from local equipment operator (e.g., valve actuator).
- **Local Automatic**: The equipment is automatically controlled locally by the packaged equipment PLC or through a hardwired interlocking scheme.

- **Remote Manual**: The equipment is manually controlled through the PLC based on commands issued from an HMI. Such commands are received by the PLC and converted into physical outputs to field devices.
- **Remote Automatic**: The equipment will be automatically controlled through the PLC according to measured process parameters or calculated values received from field devices or remote PLCs and upon commands and setpoints issued from an HMI. Such commands, setpoints, and process values are received by the local PLC, processed, and converted into physical outputs to field devices in order to maintain a process setpoint or specific control scheme. Some equipment may have more than one remote automatic control mode.

In all control modes, hardwired equipment interlocks will be used to shut down equipment as required to protect plant personnel or equipment. Where such interlocks and permissive signals are monitored by the control system, the PLC will discontinue the control output to equipment, concurrent with the equipment's interruption by the hardwired circuit.

The control mode will be selectable where applicable according to local/remote and auto/manual switches located at the devices, AFD, MCC, and/or control panels. Selector switch position feedback will be wired to the PLC, allowing an operator to know whether a device is available for remote control from the HMI.

Some non-process equipment will be provided with local manual and local automatic controls only. Where applicable, packaged equipment items that are normally provided with local automatic controls will be specified accordingly. The PLC will be used to monitor such equipment and, when applicable, provide remote initiation, monitoring, and alarming.

8.7 EQUIPMENT CONTROLS

The specific equipment controls for each process will be developed into process control software block descriptions and will be provided as part of the bid documents.

Specific interlocks, permissives, alarms, and automatic control strategies will be further developed during detailed design phases. A process may have multiple automatic control modes. The following table describes the various modes of control available for specific processes.

Table 8-1 Automation Philosophy

PROCESS DESCRIPTION
Gravity Filters
A. **Local Manual Control:** Valve actuators associated with the gravity filters may be manually operated.
B. **Local Automatic Control:** None.
C. **Remote Manual Control:** Manual control of valve actuators associated with the gravity filters will be available at PCS HMI.
D. **Remote Automatic Control:** The PCS will modulate influent flow, filtrate flow, and will initiate backwash cycles based on operator-entered setpoints.

PROCESS DESCRIPTION

Backwash Supply Pump

A. **Local Manual Control:** Pump controls will be available at the local control station.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of the backwash supply pump will be available at the PCS HMI. Pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The PCS will start, stop and modulate pump speed to maintain an operator-entered flow setpoint.

* In the event of a Backwash Supply Pump failure, one High Service Water Pump connected to the Backwash Supply Header will serve as a backup pump. To be coordinated during detailed design.

Backwash Filter Return Pumps

A. **Local Manual Control:** Pump controls will be available at the AFD panel.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of backwash filter return pumps will be available at the PCS HMI. Pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The pumps will operate in a Lead/Lag/Standby configuration and the PCS will modulate pump speed to maintain an operator-entered flow setpoint.

High Service Water Pumps

A. **Local Manual Control:** Pump controls will be available at the AFD panel.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of high service pump will be available at the PCS HMI. Pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The pumps will operate in a Lead/Lag1/Standby configuration and the PCS will modulate pump speed to maintain an operator-entered setpoint. Several remote automatic control modes may be available, allowing operators to toggle between flow control, pressure control, and level control.

*Note a separately sized pump will be provided for the Lake of the Forest service area. Ability to use the backup pump as a backup for this service area will be evaluated during design.

High-Rate Clarifier Equipment System

A. **Local Manual Control:** Manual controls will be available on the system control panel.

B. **Local Automatic Control:** The softening equipment system will be supplied as a vendor package. It is anticipated that most control will be at the vendor package level with supervisory commands issued by the PCS. Local automatic controls to be further refined during detailed design phases.

C. **Remote Manual Control:** Manual control of the system will be available at the PCS HMI.

D. **Remote Automatic Control:** The PCS will issue start/stop commands to the vendor softening equipment system. Remote automatic controls to be further refined during detailed design phases.

PROCESS DESCRIPTION

Chemical Feed Systems

Sodium Hypochlorite Feed System

A. **Local Manual Control:** Manual controls will be available on the metering pump control panels.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of the feed pumps will be available at the PCS HMI. Pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The pumps will operate in a Duty/Standby configuration and the PCS will modulate pump speed to maintain an operator-entered dosage setpoint. Additional detail on the feedback parameters and calculations will be determined during detailed design.

Coagulant Feed System

A. **Local Manual Control:** Manual controls will be available on the metering pump control panels.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of the feed pumps will be available at the PCS HMI. Control of pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The pumps will operate in a Duty/Standby configuration and the PCS will modulate pump speed to maintain an operator-entered dosage setpoint. Additional detail on the feedback parameters and calculations will be determined during detailed design.

Fluoride Feed System

A. **Local Manual Control:** Manual controls will be available on the metering pump local control panels.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of the feed pumps will be available at the PCS HMI. Control of pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The pumps will operate in a Duty/Standby configuration and the PCS will modulate pump speed to maintain an operator-entered dosage setpoint. Additional detail on the feedback parameters and calculations will be determined during detailed design.

Phosphate Feed System

A. **Local Manual Control:** Manual controls will be available on the metering pump local control panels.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of the feed pumps will be available at the PCS HMI. Control of pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The pumps will operate in a Duty/Standby configuration and the PCS will modulate pump speed to maintain an operator-entered dosage setpoint. Additional detail on the feedback parameters and calculations will be determined during detailed design.

PROCESS DESCRIPTION

Liquid Ammonium Sulfate Feed System

A. **Local Manual Control:** Manual controls will be available on the metering pump local control panels.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of the feed pumps will be available at the PCS HMI. Control of pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The pumps will operate in a Lead/Lag configuration and the PCS will modulate pump speed to maintain an operator-entered dosage setpoint. Additional detail on the feedback parameters and calculations will be determined during detailed design.

Polymer Feed System

A. **Local Manual Control:** Manual controls will be available on the metering pump local control panels.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of the feed pumps will be available at the PCS HMI. Control of pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The pumps will operate in a Lead/Lag/Standby configuration and the PCS will modulate pump speed to maintain an operator-entered dosage setpoint. Additional detail on the feedback parameters and calculations will be determined during detailed design.

Carbon Dioxide Feed System

A. **Local Manual Control:** Manual controls will be available on the system control panel.

B. **Local Automatic Control:** It is anticipated that the carbon dioxide feed system will be supplied as a vendor package. Local automatic controls to be further refined during detailed design phases.

C. **Remote Manual Control:** Manual control of the feeder system will be available at the PCS HMI. Control of feeder operation and feed rate will be available at the PCS HMI.

D. **Remote Automatic Control:** None.

Lime Feed System

A. **Local Manual Control:** Manual controls will be available on the system control panel.

B. **Local Automatic Control:** It is anticipated that the lime feed system will be supplied as a vendor package. Local automatic controls to be further refined during detailed design phases.

C. **Remote Manual Control:** Manual control of the feed system will be available at the PCS HMI. Control of system operation and feed rate will be available at the PCS HMI.

D. **Remote Automatic Control:** The feeders will operate in a Duty/Standby configuration and the PCS will modulate feed rate to maintain an operator-entered dosage setpoint. Additional detail on the feedback parameters and calculations will be determined during detailed design.

PROCESS DESCRIPTION

Soda Ash Feed System

A. **Local Manual Control:** Manual controls will be available on the system control panel.

B. **Local Automatic Control:** It is anticipated that the soda ash feed system will be supplied as a vendor package. Local automatic controls to be further refined during detailed design phases.

C. **Remote Manual Control:** Manual control of the feed system will be available at the PCS HMI. Control of system operation and feed rate will be available at the PCS HMI.

D. **Remote Automatic Control:** The feed pumps will operate in a Duty/Standby configuration and the PCS will modulate feed rate to maintain an operator-entered dosage setpoint. Additional detail on the feedback parameters and calculations will be determined during detailed design.

Backup Power Generator

A. **Local Manual Control:** Manual controls will be available on the engine-generator control panel.

B. **Local Automatic Control:** The engine-generator packaged will be equipped with a microcontroller to provide automatic control at the local level.

C. **Remote Manual Control:** Manual control of the generator will be available at the PCS HMI.

D. **Remote Automatic Control:** None.

Appendix A

Conceptual Opinion of Probable Construction Cost

Summary of Capital Costs for a New High Rate Softening Plant

Structure	Cost
Packaged Softening Equipment	$1,611,100
Lime-Soda Ash Storage and Feed Systems	$2,205,800
Recarbonation Basin & CO2 Feed System	$415,700
Operations Building	$3,358,700
High Service Pump Station	$393,500
Treated Water Reservoir	$678,300
Lime Residual Treatment Facility	$178,900
Natural Gas Generator	$223,000
Backwash Storage & Pump Station	$472,700
Sitework	$860,300
Electrical and I&C	$531,900
Contingency (15% excluding equipment costs)	$1,393,500
General Requirements, OH&P, Insurance & Bonds (20%)	$2,509,900
Total Conceptual Opinion of Probable Construction Cost	**$14,833,000**
Engineering, Legal & Administration (20% of Construction Cost)	$2,966,600
Total Conceptual Opinion of Probable Project Costs	**$17,800,000**

WTP High- Rate System
City of Bonner Springs, KS
Opinion of Probable Construction Costs - 10%

Project name	High-Rate System
Labor rate table	NA-OPCC-20
Equipment rate table	Bluebook-19
Report format	Sorted by 'Area/MF95Lvl02/Element' 'Detail' summary

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
0100 SITEWORK									
02200 Site Preparation									
0100.02200.0000 Clear & Grub									
Clear & Grub Site - Chip on site and haul	2.00 acre	80	5,036	-	13,641	-	-	9,338.44 /acre	18,677
0100.02200.0000 Clear & Grub	**2.00 acre**	**80**	**5,036**		**13,641**			**9,338.44 /acre**	**18,677**
0100.02200.1000 Construction Entrance									
ASTM D448 #357 Stone (2.00- No. 4)	15.00 cy		-	168	-		-	11.20 /cy	168
Haul import fill, 18 cy dump truck, 35 mph average, cycle 40 miles	15.00 cy	1	83	-	107	-	-	12.70 /cy	191
Filter Fabric	600.00 sf	4	220	450	-	-	-	1.12 /sf	670
0100.02200.1000 Construction Entrance	**450.00 sf**	**5**	**304**	**618**	**107**			**2.29 /sf**	**1,029**
02200 Site Preparation		**85**	**5,340**	**618**	**13,748**				**19,706**
02300 Earthwork									
0100.02300.0000 Site Grading and Shaping									
ROUGH GRADING - Sites, 30,000 to 100,000 sf, Grader 140M	87,120.00 sf	105	5,968	43,560	2,603	-	-	0.60 /sf	52,132
0100.02300.0000 Site Grading and Shaping	**87,120.00 sf**	**105**	**5,968**	**43,560**	**2,603**			**0.60 /sf**	**52,132**
02300 Earthwork		**105**	**5,968**	**43,560**	**2,603**				**52,132**
02370 Erosion and Sedimentation Control									
0100.02370.0000 Silt Fencing									
Silt Fence with Fabric Including Maintenance	790.00 lf	42	2,322	3,555	-	-	-	7.44 /lf	5,877
0100.02370.0000 Silt Fencing	**790.00 lf**	**42**	**2,322**	**3,555**				**7.44 /lf**	**5,877**
02370 Erosion and Sedimentation Control		**42**	**2,322**	**3,555**					**5,877**
02510 Water Utility Distribution Piping									
0100.02510.0000 Site Water Service									
4' DIP Restrained Joint Class 53 Pipe w/Fittings & Valves	300.00 lf	105	5,924	31,500	2,641	-	-	133.55 /lf	40,065
0100.02510.0000 Site Water Service	**300.00 lf**	**105**	**5,924**	**31,500**	**2,641**			**133.55 /lf**	**40,065**
02510 Water Utility Distribution Piping		**105**	**5,924**	**31,500**	**2,641**				**40,065**
02530 Sanitary Sewerage									
0100.02530.0000 Site Sanitary Sewerage Piping w/Manholes & Fittings									
Site Sanitary Sewerage Piping 6"	350.00 lf	123	6,911	14,000	3,081	-	-	68.55 /lf	23,992
0100.02530.0000 Site Sanitary Sewerage Piping w/Manholes & Fittings	**350.00 lf**	**123**	**6,911**	**14,000**	**3,081**			**68.55 /lf**	**23,992**
02530 Sanitary Sewerage		**123**	**6,911**	**14,000**	**3,081**				**23,992**
02600 Drainage and Containment									
0100.02600.0000 Storm Water Drainage Systems									
Storm Pipe & Structures	37,500.00 sf	210	11,847	46,875	5,282	-	-	1.71 /sf	64,004
0100.02600.0000 Storm Water Drainage Systems	**37,500.00 sf**	**210**	**11,847**	**46,875**	**5,282**			**1.71 /sf**	**64,004**
02600 Drainage and Containment		**210**	**11,847**	**46,875**	**5,282**				**64,004**
02700 Bases, Ballasts, Pavements, and Appurtenances									
0100.02700.1000 Asphalt Paved Roadway 6" Base 4" Asphalt									
--Finish Grade Base Course, Plant Roadways	3,180.00 sy	70	4,151	-	2,372	-	-	2.05 /sy	6,522
Mob/Demob Asphalt Paving Equipment	1.00 ea		-	-	-	2,875	-	2,875.00 /ea	2,875
Asphalt Paving, Wearing Course, 4" thick	3,180.00 sy		-	91,425	-	-	-	28.75 /sy	91,425
-- Install Asphalt Paving, Wearing Course, 4" thick	3,180.00 sy	98	5,645	-	2,406	-	-	2.53 /sy	8,051
Asphalt Paving, Prime Coat, Emulsion, .30 gal/sy	3,180.00 sy		-	-	-	9,826	-	3.09 /sy	9,826
Asphalt Paving, Tack Coat, Emulsion, .10 gal/sy	3,180.00 sy		-	-	-	4,643	-	1.46 /sy	4,643
Layout of Pavement Marking	180.00 lf		-	-	-	9	-	0.05 /lf	9
Pavement Striping, Painted, 4" Wide	180.00 lf		-	-	-	45	-	0.25 /lf	45
0100.02700.1000 Asphalt Paved Roadway 6" Base 4" Asphalt	**3,180.00 sy**	**168**	**9,795**	**91,425**	**4,778**	**17,398**		**38.80 /sy**	**123,396**
02700 Bases, Ballasts, Pavements, and Appurtenances		**168**	**9,795**	**91,425**	**4,778**	**17,398**			**123,396**
02775 Sidewalk									
0100.02775.0000 Sidewalks at Building									
Import Aggregate Base Fill	34.57 cy		-	519	-		-	15.00 /cy	519
-- Fine Grade Foundation	1,867.00 sf	15	828	-	-	-	-	0.44 /sf	828
Slab-on-Grade (Edge Form Mat'l), 1-Use	317.84 sf		-	477	-	-	-	1.50 /sf	477
-- Install Slab-on-Grade (Edge Forms), 1-Use	317.84 sf	8	512	-	-	-	-	1.61 /sf	512
SOG Form Oil & Hardware	317.84 sf		-	159	-	-	-	0.50 /sf	159
SOG Rebar and Accessories/Unload & Store	0.39 ton	0	7	4	2	-	-	33.16 /ton	13
SOG Rebar	0.39 ton		-	373	-	-	-	950.00 /ton	373
-- Install SOG Rebar	0.39 ton	6	464	-	-	-	-	1,179.82 /ton	464
WWM 6x6- W 2.1 x W 2.1 Sheets	1,867.00 sf	6	421	485	-	-	-	0.49 /sf	907
4000 psi Concrete	34.05 cy		-	4,086	-	-	-	120.00 /cy	4,086
4000 psi Concrete (Waste)	2.38 cy		-	286	-	-	-	120.00 /cy	286
Ice Chips	34.05 cy		-	851	-	-	-	25.00 /cy	851
Place SOG, Direct Chute	34.05 cy	9	461	-	-	-	-	13.55 /cy	461

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
0100.02775.0000 Sidewalks at Building									
Broom Finish SOG	1,867.00 sf	9	568	-	-	-	-	0.30 /sf	568
Burlap Blanket & Water Cure 4 Use	1,867.00 sf	5	284	45	-	-	-	0.18 /sf	329
0100.02775.0000 Sidewalks at Building	34.05 cy	58	3,545	7,284	2			318.12 /cy	10,832
02775 Sidewalk		58	3,545	7,284	2				10,832
02800 Site Improvements and Amenities									
0100.02800.0000 Site Restoration, Grassing & Landscaping									
Site Restoration, Landscaping & Planting	43,244.00 sf	259	14,219	36,757	2,378	-	-	1.23 /sf	53,355
0100.02800.0000 Site Restoration, Grassing & Landscaping	43,244.00 sf	259	14,219	36,757	2,378			1.23 /sf	53,355
02800 Site Improvements and Amenities		259	14,219	36,757	2,378				53,355
02820 Fences and Gates									
0100.02820.0000 Site Perimeter Fencing 6'-0" High									
Chain Link Fencing, Galvanized Steel, in Concrete, 6-ft high	1,270.00 lf		-	-	-	33,284	-	26.21 /lf	33,284
Chain Link, Dbl Swing Gate, 20-ft wide x 6-ft high, Manual	1.00 ea		-	-	-	740	-	740.00 /ea	740
0100.02820.0000 Site Perimeter Fencing 6'-0" High	1,270.00 lf					34,024		26.79 /lf	34,024
02820 Fences and Gates						34,024			34,024
0100 SITEWORK		**1,155**	**65,872**	**275,575**	**34,514**	**51,422**			**427,383**
0200 OPERATIONS BUILDING									
02700 Bases, Ballasts, Pavements, and Appurtenances									
0200.02760.1000 Bollards at Roll-up Door									
Pipe Bollards, Concrete Filled/Painted, 8' long x 4' deep hole, 8" dia	4.00 ea		-	3,000	-	-	-	750.00 /ea	3,000
Pipe Bollards, Concrete Filled/Painted, 8' long x 4' deep hole, 8" dia	9.00 ea		-	6,750	-	-	-	750.00 /ea	6,750
--Install Pipe Bollards, Concrete Filled/Painted, 8' long x 4' deep hole, 8" diameter	4.00 ea	16	882	-		-	-	220.49 /ea	882
--Install Pipe Bollards, Concrete Filled/Painted, 8' long x 4' deep hole, 8" diameter	9.00 ea	36	1,984	-		-	-	220.49 /ea	1,984
0200.02760.1000 Bollards at Roll-up Door	4.00 ea	52	2,866	9,750				3,154.09 /ea	12,616
02700 Bases, Ballasts, Pavements, and Appurtenances		52	2,866	9,750					12,616
03300 Concrete, Placement and Finishing									
0200.03300.0000 Slab on Grade w/TD & Col Footings - Eq. Pads Etc...									
Slab on Grade & Foundation Rebar	184.00 ton	2,944	227,927	174,800	0	-	-	2,188.74 /ton	402,727
4000 psi Concrete	552.00 cy		-	66,240	-	-	-	120.00 /cy	66,240
Concrete Forming Pads,	552.00 cy	1,932	130,793	27,600	4,830	-	-	295.69 /cy	163,223
Place SOG, Pumped	552.00 cy	276	14,956	-	-	-	-	27.09 /cy	14,956
Machine Trowel Finish SOG	9,938.00 sf	199	12,190	-	175	-	-	1.24 /sf	12,365
SOG Concrete Pump- 170' Boom (52m)	552.00 cy		-	-	-	6,900	2,208	16.50 /cy	9,108
0200.03300.0000 Slab on Grade w/TD & Col Footings - Eq. Pads Etc...	552.00 cy	5,351	385,866	268,640	5,005	6,900	2,208	1,211.27 /cy	668,619
03300 Concrete, Placement and Finishing		5,351	385,866	268,640	5,005	6,900	2,208		668,619
03400 Precast Concrete									
0200.03450.0000 6" Hollow Core Plank Ceiling NaOCL Room									
Hollow Core Plank 6"	449.00 sf		-	2,919	-	-	-	6.50 /sf	2,919
-- Install Hollow Core Plank 6"	449.00 sf	36	2,432	-	382	-	-	6.27 /sf	2,813
0200.03450.0000 6" Hollow Core Plank Ceiling NaOCL Room	449.00 sf	36	2,432	2,919	382			12.77 /sf	5,732
0200.03450.1000 6" Hollow Core Plank Ceiling Coagulant Room									
Hollow Core Plank 6"	282.00 sf		-	1,833	-	-	-	6.50 /sf	1,833
-- Install Hollow Core Plank 6"	282.00 sf	23	1,527	-	240	-	-	6.27 /sf	1,767
0200.03450.1000 6" Hollow Core Plank Ceiling Coagulant Room	282.00 sf	23	1,527	1,833	240			12.77 /sf	3,600
03400 Precast Concrete		58	3,959	4,752	621				9,332
04200 Masonry Units									
0200.04200.1000 Exterior Split Face Block									
Mortar Cement, Type S, Brick and/or Block, premixed	120.96 cf		-	1,475	-	-	-	12.19 /cf	1,475
Masonry grout, 8" Block	7.00 cy		-	770	-	-	-	110.00 /cy	770
-- Place masonry grout, pumped, 8" block	7.00 cy	18	1,157	-	60	-	-	173.85 /cy	1,217
Masonry grout at Door Frames, 3' x 7' opening, 2.5 cf/opening	5.00 opng		-	69	-	-	-	13.78 /opng	69
Masonry grout at Door Frames, 6' x 7' opening, 3.5 cf/opening	1.00 opng		-	19	-	-	-	19.24 /opng	19
-- Place masonry grout at Door Frames, pumped, 3' x 7' opening, 2.5 cf/opening	5.00 opng	13	881	-	46	-	-	185.32 /opng	927
-- Place masonry grout at Door Frames, pumped, 6' x 7' opening, 3.5 cf/opening	1.00 opng	4	235	-	12	-	-	247.21 /opng	247
Truss or Ladder Reinforcement 8", 9 Ga	1,053.00 lf		-	256	-	-	-	0.24 /lf	256
Masonry Rebar # 4	0.23 ton		-	222	-	-	-	950.00 /ton	222
-- Install Masonry Rebar	0.23 ton	4	254	-	-	-	-	1,083.40 /ton	254
Rubber Masonry Control & Exp. Jt., Cross Shaped	70.00 lf		-	126	-	-	-	1.79 /lf	126
-- Install Rubber Masonry Control & Exp. Jt., Cross Shaped	70.00 lf	2	137	-	-	-	-	1.96 /lf	137
Decorative Block, Split Face, 8"x8"x16"	1,400.00 sf		-	6,790	-	-	-	4.85 /sf	6,790
-- Install Decorative Block, Split Face, 8"x8"x16"	1,400.00 sf	140	9,480	-	-	-	-	6.77 /sf	9,480
Cast Stone, Sill	400.00 lf		-	14,000	-	-	-	35.00 /lf	14,000

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
0200.04200.1000 Exterior Split Face Block									
-- Install Cast Stone, Sill	400.00 lf	27	1,806	-	-	-	-	4.51 /lf	1,806
Clean Block	1,400.00 sf	5	276	53	40	-	-	0.26 /sf	368
Silicone Based Sprayed-on Water Repellent 2 coat	1,400.00 sf		-	1,372	-	-	-	0.98 /sf	1,372
-- Install Silicone Based Sprayed-on Water Repellent 2 coat	1,400.00 sf	4	189	-	-	-	-	0.14 /sf	189
Masonry Loose-Fill Insulation, 8" thick wall, .258 cf/sf	1,400.00 sf		-	2,240	-	-	-	1.60 /sf	2,240
-- Install Masonry Loose-Fill Insulation, 8" thick wall,	1,400.00 sf	10	664	-	-	-	-	0.47 /sf	664
0200.04200.1000 Exterior Split Face Block	**1,400.00 sf**	**226**	**15,078**	**27,392**	**157**			**30.45 /sf**	**42,627**
10.0200.04200.1010 8" CMU Walls Interior									
Scaffolding (Rental)	1.00 mo		-	-	-	1,000	-	1,000.00 /mo	1,000
Stage and Setup Scaffolding	14,325.16 sf	57	3,753	-	-	-	-	0.26 /sf	3,753
Tear Down and Remove Scaffolding	14,325.16 sf	57	3,753	-	-	-	-	0.26 /sf	3,753
Mortar Cement, Type S, Brick and/or Block, premixed	1,119.20 cf		-	13,643	-	-	-	12.19 /cf	13,643
Mortar Cement, Type S, Brick and/or Block, premixed	118.49 cf		-	1,444	-	-	-	12.19 /cf	1,444
Masonry grout, 8" Block	64.77 cy		-	7,125	-	-	-	110.00 /cy	7,125
Masonry grout, 8" Block	6.86 cy		-	754	-	-	-	110.00 /cy	754
-- Place masonry grout, pumped, 8" block	64.77 cy	162	10,707	-	553	-	-	173.85 /cy	11,260
-- Place masonry grout, pumped, 8" block	6.86 cy	17	1,133	-	59	-	-	173.85 /cy	1,192
Masonry grout at Door Frames, 3' x 7' opening, 2.5 cf/opening	8.00 opng		-	110	-	-	-	13.78 /opng	110
Masonry grout at Door Frames, 6' x 7' opening, 3.5 cf/opening	10.00 opng		-	192	-	-	-	19.24 /opng	192
-- Place masonry grout at Door Frames, pumped, 3' x 7' opening, 2.5 cf/opening	8.00 opng	21	1,410	-	73	-	-	185.32 /opng	1,483
-- Place masonry grout at Door Frames, pumped, 6' x 7' opening, 3.5 cf/opening	10.00 opng	36	2,351	-	121	-	-	247.21 /opng	2,472
Truss or Ladder Reinforcement 8", 9 Ga	9,740.00 lf		-	2,372	-	-	-	0.24 /lf	2,372
Truss or Ladder Reinforcement 8", 9 Ga	1,032.00 lf		-	251	-	-	-	0.24 /lf	251
Masonry Rebar # 5	3.38 ton		-	3,209	-	-	-	950.00 /ton	3,209
Masonry Rebar # 5	0.36 ton		-	340	-	-	-	950.00 /ton	340
-- Install Masonry Rebar	3.38 ton	54	3,660	-	-	-	-	1,083.44 /ton	3,660
-- Install Masonry Rebar	0.36 ton	6	388	-	-	-	-	1,083.44 /ton	388
Rubber Masonry Control & Exp. Jt., Cross Shaped	645.00 lf		-	1,157	-	-	-	1.79 /lf	1,157
-- Install Rubber Masonry Control & Exp. Jt., Cross Shaped	645.00 lf	19	1,267	-	-	-	-	1.96 /lf	1,267
Standard Block, Normal Wt., 8"x8"x16"	12,953.75 sf		-	49,095	-	-	-	3.79 /sf	49,095
Standard Block, Normal Wt., 8"x8"x16"	1,371.41 sf		-	5,198	-	-	-	3.79 /sf	5,198
-- Install Standard Block, Normal Wt., 8"x8"x16"	12,953.75 sf	648	43,858	-	-	-	-	3.39 /sf	43,858
-- Install Standard Block, Normal Wt., 8"x8"x16"	1,371.41 sf	69	4,643	-	-	-	-	3.39 /sf	4,643
Bond Beam, regular block, including grout and 2 #5 bar, 8"	2,410.00 lf		-	13,954	-	-	-	5.79 /lf	13,954
Bond Beam, regular block, including grout and 2 #5 bar, 8"	171.68 lf		-	994	-	-	-	5.79 /lf	994
-- Install Bond Beam, regular block, including grout and 2 #5 bar, 8"	2,410.00 lf	321	21,705	-	-	-	-	9.01 /lf	21,705
-- Install Bond Beam, regular block, including grout and 2 #5 bar, 8"	171.68 lf	23	1,546	-	-	-	-	9.01 /lf	1,546
Lintel Block, including grout and 2 #4 bar, 8" thick	107.94 lf		-	497	-	-	-	4.60 /lf	497
-- Install Lintel Block, including grout and 2 #4 bar, 8" thick	107.94 lf	13	870	-	-	-	-	8.06 /lf	870
Clean Block	25,907.50 sf	94	5,102	976	738	-	-	0.26 /sf	6,816
Clean Block	2,742.81 sf	10	540	103	78	-	-	0.26 /sf	722
10.0200.04200.1010 8" CMU Walls Interior	**14,325.16 sf**	**1,606**	**106,684**	**101,414**	**1,622**	**1,000**		**14.71 /sf**	**210,720**
04200 Masonry Units		**1,832**	**121,762**	**128,806**	**1,779**	**1,000**			**253,347**
05500 Metal Fabrications									
0200.05500.0000 FRP Floor Grating									
FRP Grating Pultruded - 1-1/4 x 3/16	657.00 sf		-	23,488	-	-	-	35.75 /sf	23,488
-- Install FRP Grating	657.00 sf	66	5,122	-	-	-	-	7.80 /sf	5,122
0200.05500.0000 FRP Floor Grating	**657.00 sf**	**66**	**5,122**	**23,488**				**43.55 /sf**	**28,610**
0200.05500.0100 Misc Bldg Metals									
Misc Angles, wall bracing, etccc.	9,938.00 sf	50	3,874	18,261	-	-	-	2.23 /sf	22,135
0200.05500.0100 Misc Bldg Metals	**9,938.00 sf**	**50**	**3,874**	**18,261**				**2.23 /sf**	**22,135**
05500 Metal Fabrications		**115**	**8,997**	**41,749**					**50,745**
08100 Metal Doors and Frames									
0200.08100.0000 Doors Frames and Hardware									
Door: Metal w/Glaziing HC 3- 0x 7-0 18 ga	2.00 ea		-	1,350	-	-	-	675.00 /ea	1,350
Door: Metal Slab HC 3- 0x 7-0 18 ga	27.00 ea		-	7,256	-	-	-	268.75 /ea	7,256
HMFrame: 3-0x 7-0 16 ga welded LH	9.00 ea		-	1,125	-	-	-	125.00 /ea	1,125
HMFrame: Pr 3-0x 7-0 16 ga welded OutSwing	10.00 ea		-	1,800	-	-	-	180.00 /ea	1,800
-- Install Hardware	29.00 ea	116	7,901	-	-	-	-	272.44 /ea	7,901
Hardware Material	29.00 ea		-	20,300	-	-	-	700.00 /ea	20,300
0200.08100.0000 Doors Frames and Hardware	**29.00 ea**	**116**	**7,901**	**31,831**				**1,370.07 /ea**	**39,732**
08100 Metal Doors and Frames		**116**	**7,901**	**31,831**					**39,732**
08300 Specialty Doors									
0200.08300.0000 Overhead Coiling Door - Insulated - Motor Operated									

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
0200.08300.0000 Overhead Coiling Door - Insulated - Motor Operated									
Coil Door: Alum 12x14	1.00 ea		-	-	-	10,000	-	10,000.00 /ea	10,000
0200.08300.0000 Overhead Coiling Door - Insulated - Motor Operated	**1.00 ea**					**10,000**		**10,000.00 /ea**	**10,000**
08300 Specialty Doors						**10,000**			**10,000**
08500 Windows									
0200.08500.0000 Aluminum Windows									
Windows Fixed Aluminum - Insulated	1,508.00 sf			26,390	-	-	-	17.50 /sf	26,390
--Install Fixed Aluminum Window - Insulated	1,508.00 sf	60	4,484		-	-	-	2.97 /sf	4,484
0200.08500.0000 Aluminum Windows	**1,508.00 sf**	**60**	**4,484**	**26,390**				**20.47 /sf**	**30,874**
0200.08500.1250 Interior Windows at Offices									
Windows Fixed Aluminum - Tempered	32.00 sf			272	-	-	-	8.50 /sf	272
--Install Fixed Aluminum Window - Tempered	32.00 sf	1	95		-	-	-	2.97 /sf	95
0200.08500.1250 Interior Windows at Offices	**32.00 sf**	**1**	**95**	**272**				**11.47 /sf**	**367**
08500 Windows		**62**	**4,579**	**26,662**					**31,241**
09200 Plaster And Gypsum Board									
0200.09200.2000 Frame & Drywall Perimeter Wall Admin Area									
Layout Interior Partitions	160.00 lf	3	216	-	-	-	-	1.35 /lf	216
Stud: 358x10' 20 ga	139.00 ea	70	4,683	601	-	-	-	38.01 /ea	5,284
Track 20 ga 3-5/8"	320.00 lf	3	216	152	-	-	-	1.15 /lf	367
Extra Time for Orange Peal Finish Wall	1,600.00 sf	16	1,078	-	-	-	-	0.67 /sf	1,078
Hang Drywall: Walls	1,600.00 sf	27	1,797	-	-	-	-	1.12 /sf	1,797
Tape & Finish Walls	1,600.00 sf	14	971	-	-	-	-	0.61 /sf	971
GWB 5/8 x 4 x10 Regular	1,600.00 sf		-	579	-	-	-	0.36 /sf	579
Pins & Loads 3/4"	40.00 ea		-	15	-	-	-	0.37 /ea	15
Corner Bead 1-1/8 x 1-1/8 x10'	6.00 ea		-	11	-	-	-	1.80 /ea	11
0200.09200.2000 Frame & Drywall Perimeter Wall Admin Area	**1,600.00 sf**	**133**	**8,960**	**1,358**				**6.45 /sf**	**10,318**
09200 Plaster And Gypsum Board		**133**	**8,960**	**1,358**					**10,318**
09500 Ceilings									
0200.09500.0000 Acoustical Ceilings 2 x 4									
Main Tee: Aluminum Capped (L&M)	1,406.50 lf	28	1,912	296	-	-	-	1.57 /lf	2,209
Cross Tee: 4' Aluminum Capped (L&M)	703.25 ea	56	3,824	947	-	-	-	6.78 /ea	4,771
Cast Tegular Std 2x4 5/8" (L&M)	2,813.00 sf	29	1,992	4,878	-	-	-	2.44 /sf	6,870
0200.09500.0000 Acoustical Ceilings 2 x 4	**2,813.00 sf**	**114**	**7,729**	**6,121**				**4.92 /sf**	**13,850**
02000.09500.1000 Gypsum Board Ceilings									
-- Install Drywall Ceiling Framing	1,061.00 sf	42	2,873		-	-	-	2.71 /sf	2,873
Stud: "C" 4"x16' 22 ga	1,061.00 sf		-	1,229	-	-	-	1.16 /sf	1,229
GWB 5/8 x 4 x 8-6" Regular	1,061.00 sf		-	716	-	-	-	0.68 /sf	716
-- Install & Finish Drywall	1,061.00 sf	35	1,560		-	-	-	1.47 /sf	1,560
02000.09500.1000 Gypsum Board Ceilings	**1,061.00 sf**	**78**	**4,433**	**1,946**				**6.01 /sf**	**6,379**
09500 Ceilings		**192**	**12,162**	**8,067**					**20,229**
09600 Flooring									
0200.09600.0080 Vinyl Flooring w/Rubber Base 6"									
Vinyl: VCT Tile 12x12 - 1/8" (L&M)	1,181.00 sf	19	1,039	1,241	-	-	-	1.93 /sf	2,280
0200.09600.0080 Vinyl Flooring w/Rubber Base 6"	**1,181.00 sf**	**19**	**1,039**	**1,241**				**1.93 /sf**	**2,280**
0200.09600.0090 Anti-Static Flooring									
Anti-Static Flooring (L&M)	228.00 sf	9	626	663	-	-	-	5.65 /sf	1,289
0200.09600.0090 Anti-Static Flooring	**228.00 sf**	**9**	**626**	**663**				**5.65 /sf**	**1,289**
0200.09600.0100 Carpet Tiles									
Install Carpet	48.78 sy	10	541	-	-	-	-	11.09 /sy	541
Carpet Tile: 35.oz	48.78 sy		-	1,462	-	-	-	29.98 /sy	1,462
0200.09600.0100 Carpet Tiles	**48.78 sy**	**10**	**541**	**1,462**				**41.06 /sy**	**2,003**
0200.09600.0110 Ceramic Tile Restroom Floor w/Ceramic Base									
Install Floor Tile 8x8 (thin set)	162.00 sf	16	948	-	-	-	-	5.85 /sf	948
Ceramic Tile 8x 8 (level 1)	162.00 sf		-	542	-	-	-	3.35 /sf	542
Grout	45.36 lbs		-	77	-	-	-	1.71 /lbs	77
Thin Set (50 lb bag)	162.00 sf		-	47	-	-	-	0.29 /sf	47
0200.09600.0110 Ceramic Tile Restroom Floor w/Ceramic Base	**162.00 sf**	**16**	**948**	**667**				**9.97 /sf**	**1,615**
09600 Flooring		**54**	**3,154**	**4,033**					**7,186**
09900 Paints and Coatings									
0200.09900.0000 Paint Doors & Frames									
Paint Doors & Frames	29.00 ea	58	2,559	616	-	-	-	109.49 /ea	3,175
0200.09900.0000 Paint Doors & Frames	**29.00 ea**	**58**	**2,559**	**616**				**109.49 /ea**	**3,175**
0200.09900.0010 Paint Interior Ceilings									

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
0200.09900.0010 Paint Interior Ceilings									
Flat @ Ceiling (2 coat rolled)	1,061.00 sf		-	303	-	-	-	0.29 /sf	303
-- Paint Ceiling Labor	1,061.00 sf	21	936		-	-	-	0.88 /sf	936
0200.09900.0010 Paint Interior Ceilings	**1,061.00 sf**	**21**	**936**	**303**				**1.17 /sf**	**1,239**
0200.09900.0030 Paint Process Piping and Valves - Allowance									
LIFT - Scissor Lift - 50' Reach - 4WD	200.00 hr		-	-	2,558	-	-	12.79 /hr	2,558
Paint Process Piping and Valves Acrylic	9,938.00 sf	331	14,615	4,224	-	-	-	1.90 /sf	18,839
0200.09900.0030 Paint Process Piping and Valves - Allowance	**9,938.00 sf**	**331**	**14,615**	**4,224**	**2,558**			**2.15 /sf**	**21,397**
0200.09900.1250 Paint CMU Walls									
Semi-Gloss @ Walls - 3 Coats	18,810.00 sf		-	3,837	-	-	-	0.20 /sf	3,837
Paint Walls - 3 Coats Rolled	18,810.00 sf	314	13,832	-	-	-	-	0.74 /sf	13,832
0200.09900.1250 Paint CMU Walls	**18,810.00 sf**	**314**	**13,832**	**3,837**				**0.94 /sf**	**17,669**
0200.09900.1260 Paint Drywall Walls									
Semi-Gloss @ Walls 3 Coats	1,595.00 sf		-	325	-	-	-	0.20 /sf	325
Paint Walls 3 Coats	1,595.00 sf	21	938	-	-	-	-	0.59 /sf	938
0200.09900.1260 Paint Drywall Walls	**1,595.00 sf**	**21**	**938**	**325**				**0.79 /sf**	**1,264**
0200.09900.3000 Paint Pipe Bollards									
Pipe Bollard Paint	34.00 sf			24	-	-	-	0.71 /sf	24
--Labor Paint Pipe Bollards	34.00 sf	1	31		-	-	-	0.90 /sf	31
0200.09900.3000 Paint Pipe Bollards	**34.00 sf**	**1**	**31**	**24**				**1.61 /sf**	**55**
09900 Paints and Coatings		**746**	**32,911**	**9,330**	**2,558**				**44,798**
09960 High Performance Coatings									
0200.09960.0000 Floor Coating at Sodium Hypochlorite									
Floor Coating	449.00 sf				-	14,593	-	32.50 /sf	14,593
0200.09960.0000 Floor Coating at Sodium Hypochlorite	**449.00 sf**					**14,593**		**32.50 /sf**	**14,593**
0200.09960.0020 Epoxy Floor Coating Coagulant									
Floor Coating	282.00 sf				-	2,397	-	8.50 /sf	2,397
0200.09960.0020 Epoxy Floor Coating Coagulant	**282.00 sf**					**2,397**		**8.50 /sf**	**2,397**
0200.09960.0030 Epoxy Floor Coating Fluoride									
Floor Coating	144.00 sf				-	1,224	-	8.50 /sf	1,224
0200.09960.0030 Epoxy Floor Coating Fluoride	**144.00 sf**					**1,224**		**8.50 /sf**	**1,224**
0200.09960.0040 Epoxy Floor Coating LAS									
Floor Coating	161.00 sf				-	1,369	-	8.50 /sf	1,369
0200.09960.0040 Epoxy Floor Coating LAS	**161.00 sf**					**1,369**		**8.50 /sf**	**1,369**
0200.09960.0050 Epoxy Floor Coating Phosphate									
Floor Coating	161.00 sf				-	1,369	-	8.50 /sf	1,369
0200.09960.0050 Epoxy Floor Coating Phosphate	**161.00 sf**					**1,369**		**8.50 /sf**	**1,369**
0200.09960.0060 Epoxy Floor Coating Polymer									
Floor Coating	203.00 sf				-	1,726	-	8.50 /sf	1,726
0200.09960.0060 Epoxy Floor Coating Polymer	**203.00 sf**					**1,726**		**8.50 /sf**	**1,726**
0200.09960.0070 Concrete Floor Sealer - Elec, Mech, Parts, Future Personnel, Filter Ro									
Concrete Floor Sealer - Parts, Lab & Filter Floor	5,066.00 sf				-	6,333	-	1.25 /sf	6,333
0200.09960.0070 Concrete Floor Sealer - Elec, Mech, Parts, Future Personnel, Filter Ro	**5,066.00 sf**					**6,333**		**1.25 /sf**	**6,333**
09960 High Performance Coatings						**29,009**			**29,009**
10400 Identification Devices									
0200.10400.0000 Building Signage Allowance									
Building Signage Allowance	1.00 ls	12	604	2,000	-	-	-	2,603.66 /ls	2,604
0200.10400.0000 Building Signage Allowance	**1.00 ls**	**12**	**604**	**2,000**				**2,603.66 /ls**	**2,604**
10400 Identification Devices		**12**	**604**	**2,000**					**2,604**
11000 Equipment									
0200.11000.0000 Scissors Lift & Bumpers									
Bumpers: 4"x6"x14"	4.00 ea		-	200	-	-	-	50.00 /ea	200
Leveler 10T 6x8 Electric	1.00 ea		-	8,500	-	-	-	8,500.00 /ea	8,500
-- Install Dock Bumpers	4.00 ea	2	156	-	-	-	-	38.98 /ea	156
-- Install Dock Leveler	1.00 ea	15	1,170	-	-	-	-	1,169.51 /ea	1,170
0200.11000.0000 Scissors Lift & Bumpers	**1.00 ls**	**17**	**1,325**	**8,700**				**10,025.44 /ls**	**10,025**
11000 Equipment		**17**	**1,325**	**8,700**					**10,025**
11200 Water Supply and Treatment Equipment									
0200.11240.4010 NaOCL Transfer Pumps									
Magnetic Centrifugal Pump -1 hp - 10 gpm	2.00 ea		-	1,750	-	-	-	875.00 /ea	1,750
-- Align & Set Magnetic Centrifugal Pump	2.00 ea	8	528	-	-	-	-	264.22 /ea	528

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
0200.11240.4010 NaOCL Transfer Pumps	**2.00 ea**	**8**	**528**	**1,750**				**1,139.22 /ea**	**2,278**
0200.11240.4012 Phosphate Metering Pumps									
Peristaltic Chemical Metering Pump	2.00 ea	4	264	15,970	-	-	-	8,117.35 /ea	16,235
0200.11240.4012 Phosphate Metering Pumps	**2.00 ea**	**4**	**264**	**15,970**				**8,117.35 /ea**	**16,235**
0200.11240.4015 Cogulant Metering Pumps									
Peristaltic Chemical Metering Pump	2.00 ea	4	264	16,500	-	-	-	8,382.11 /ea	16,764
0200.11240.4015 Cogulant Metering Pumps	**2.00 ea**	**4**	**264**	**16,500**				**8,382.11 /ea**	**16,764**
0200.11240.4050 Liquid Ammonium Sulfate (LAS) Metering Pumps									
Peristaltic Chemical Metering Pump	2.00 ea	4	264	13,650	-	-	-	6,957.11 /ea	13,914
0200.11240.4050 Liquid Ammonium Sulfate (LAS) Metering Pumps	**2.00 ea**	**4**	**264**	**13,650**				**6,957.11 /ea**	**13,914**
0200.11240.4053 Fluoride Metering Pumps									
Peristaltic Chemical Metering Pump	2.00 ea	4	264	13,650	-	-	-	6,957.11 /ea	13,914
0200.11240.4053 Fluoride Metering Pumps	**2.00 ea**	**4**	**264**	**13,650**				**6,957.11 /ea**	**13,914**
0200.11240.4100 NaOCL Metering Pumps									
Peristaltic Chemical Metering Pump	2.00 ea			15,970	-	-	-	7,985.24 /ea	15,970
0200.11240.4100 NaOCL Metering Pumps	**2.00 ea**			**15,970**				**7,985.24 /ea**	**15,970**
0200.11240.4110 Polymer Metering Pumps									
Peristaltic Chemical Metering Pump	3.00 ea			23,956	-	-	-	7,985.24 /ea	23,956
0200.11240.4110 Polymer Metering Pumps	**3.00 ea**			**23,956**				**7,985.24 /ea**	**23,956**
11200 Water Supply and Treatment Equipment		**24**	**1,585**	**101,447**					**103,032**
11300 Fluid Waste Treatment & Disposal Equipment									
050.070.11.01001 Gravity Filters									
Gravity Filters	3.00 ea			801,501	-	-	-	267,167.00 /ea	801,501
-- Install GravityFilters	3.00 ea	720	47,560		4,500	-	-	17,353.20 /ea	52,060
050.070.11.01001 Gravity Filters	**3.00 ea**	**720**	**47,560**	**801,501**	**4,500**			**284,520.20 /ea**	**853,561**
11300 Fluid Waste Treatment & Disposal Equipment		**720**	**47,560**	**801,501**	**4,500**				**853,561**
12300 Manufactured Casework									
0200.1230.0000 Laboratory Casework w/Resin Tops									
Cabinets, Base	27.00 lf		-	7,020	-	-	-	260.00 /lf	7,020
Wall Cabinets	27.00 lf		-	6,075	-	-	-	225.00 /lf	6,075
-- Install Cabinets, Base	27.00 lf	24	1,637	-	-	-	-	60.62 /lf	1,637
-- Install Wall Cabinets	27.00 lf	22	1,471	-	-	-	-	54.49 /lf	1,471
Laboratory Resin Tops	27.00 lf	7	460	5,670	-	-	-	227.03 /lf	6,130
Resin Integral Laboratory Sink	1.00 ea	4	272	1,250		-	-	1,522.44 /ea	1,522
0200.1230.0000 Laboratory Casework w/Resin Tops	**27.00 lf**	**56**	**3,840**	**20,015**				**883.52 /lf**	**23,855**
12300 Manufactured Casework		**56**	**3,840**	**20,015**					**23,855**
13120 Pre-Engineered Metal Building									
0200.13120.00000 Pre-Engineered Metal Building									
LIFT - Scissor Lift - 50' Reach - 4WD	245.00 hr		-	-	3,133	-	-	12.79 /hr	3,133
LIFT - Reach Forklift - 12000 lb 42' Reach 54' Height w/ Operator	245.00 hr	245		-	17,038	-	-	69.54 /hr	17,038
Pre-Engineered Metal Bldg, Structure (5,000 - 10,000 sf)	9,938.00 sf		-	124,225	-	-	-	12.50 /sf	124,225
-- Install Pre-Engineered Metal Bldg, Structure (5,000 - 10,000 sf)	9,938.00 sf	663	51,294	-	-	-	-	5.16 /sf	51,294
Vinyl Faced Insul. - Unfaced R30 (9.0") - Walls and Roof	17,038.00 sf		-	18,742	-	-	-	1.10 /sf	18,742
-- Install Vinyl Faced Insul. - Unfaced Walls and Roof	17,038.00 sf	57	4,882	-	-	-	-	0.29 /sf	4,882
-- Install Wall Panels	7,100.00 sf	118	6,344	-	-	-	-	0.89 /sf	6,344
Wall Panels	7,100.00 sf			28,400	-	-	-	4.00 /sf	28,400
-- Install Roof Panels	9,938.00 sf	199	10,655	-	-	-	-	1.07 /sf	10,655
Roof Panels	9,938.00 sf			47,206	-	-	-	4.75 /sf	47,206
0200.13120.00000 Pre-Engineered Metal Building	**9,938.00 sf**	**1,281**	**73,175**	**218,572**	**20,171**			**31.39 /sf**	**311,918**
0200.13120.2000 Metal Liner Panels - Process Area Exterior Walls									
Metal Liner Panel	1,865.00 sf			4,383	-	-	-	2.35 /sf	4,383
--Install Metal Liner Panel	1,865.00 sf	19	1,000		513	-	-	0.81 /sf	1,513
0200.13120.2000 Metal Liner Panels - Process Area Exterior Walls	**1,865.00 sf**	**19**	**1,000**	**4,383**	**513**			**3.16 /sf**	**5,895**
13120 Pre-Engineered Metal Building		**1,300**	**74,175**	**222,955**	**20,684**				**317,814**
15100 Building Services Piping									
0200.15100.0000 Building Plumbing Services									
Building Services Plumbing	9,938.00 sf				-	124,225	-	12.50 /sf	124,225
0200.15100.0000 Building Plumbing Services	**9,938.00 sf**					**124,225**		**12.50 /sf**	**124,225**
15100 Building Services Piping						**124,225**			**124,225**
15200 Process Piping									
0200.15200.0000 Process Piping Bldg Interior - Chemical Piping									
Bldg Process Piping Valves etc...	9,938.00 sf	298	25,708	42,237	4,472	-	-	7.29 /sf	72,416

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
0200.15200.0000 Process Piping Bldg Interior - Chemical Piping	**9,938.00 sf**	**298**	**25,708**	**42,237**	**4,472**			**7.29 /sf**	**72,416**
0200.15200.1000 Process Piping Gravity Filters									
-- Disinfect & Sample Test Pipe, 14"	108.00 lf	2	117	-	26	-	-	1.33 /lf	144
-- Disinfect & Sample Test Pipe, 20"	270.00 lf	7	391	-	88	-	-	1.77 /lf	479
-- Install 14" DI Pipe, CL53, FLxFL, 10'-0"	108.00 lf	43	3,746	-	-	-	-	34.69 /lf	3,746
-- Install 20" DI Pipe, CL53, FLxFL, 10'-0"	270.00 lf	135	11,706	-	-	-	-	43.36 /lf	11,706
14" DI Mortar-Lined, Restrained Joint, Class 53, Pipe w/Fittings & Valves	108.00 LF		-	20,380	-	-	-	188.70 /LF	20,380
20" DI Mortar-Lined, Restrained Joint, Class 53, Pipe w/Fittings & Valves	270.00 LF		-	77,355	-	-	-	286.50 /LF	77,355
0200.15200.1000 Process Piping Gravity Filters	**378.00 lf**	**188**	**15,961**	**97,735**	**114**			**301.08 /lf**	**113,809**
15200 Process Piping		**486**	**41,668**	**139,971**	**4,586**				**186,226**
15300 Fire Protection Piping									
0200.15300.0000 Carbon-Dioxide Sprinkler Cogulant Room									
Carbon Dioxide Sprinkler System - dry	282.00 sf		-	5,217	-	-	-	18.50 /sf	5,217
0200.15300.0000 Carbon-Dioxide Sprinkler Cogulant Room	**282.00 sf**			**5,217**				**18.50 /sf**	**5,217**
0200.15300.1000 Carbon-Dioxide Sprinkler Sodium Hypochlorite Room									
Carbon Dioxide Sprinkler System - dry	449.00 sf		-	8,307	-	-	-	18.50 /sf	8,307
0200.15300.1000 Carbon-Dioxide Sprinkler Sodium Hypochlorite Room	**449.00 sf**			**8,307**				**18.50 /sf**	**8,307**
15300 Fire Protection Piping				**13,524**					**13,524**
15700 Heating Ventilating and Air Conditioning Equipment									
0200.15700.0000 Ventilitation & Fan at Fluoride Room									
Duct: 16" Aluminum Round Pipe	350.00 lbs		-	1,750	-	-	-	5.00 /lbs	1,750
-- Install Duct: 16" Aluminum Round Pipe	350.00 lbs	8	429	-	-	-	-	1.23 /lbs	429
Fan: Roof Mount Exhaust 1450 CFM	1.00 ea	5		3,250	-	-	-	3,250.00 /ea	3,250
-- Install Fan: Roof Mount Exhaust 1450 CFM	1.00 ea	5	246	-	-	-	-	246.14 /ea	246
Ventilitation Hood	1.00 ea	4	214	1,750	-	-	-	1,964.43 /ea	1,964
0200.15700.0000 Ventilitation & Fan at Fluoride Room	**1.00 ea**	**21**	**889**	**6,750**				**7,639.49 /ea**	**7,639**
0200.15700.1000 HVAC - Adminstrative Area									
HVAC System Adminstrative Side	3,135.00 sf				-	101,888	-	32.50 /sf	101,888
0200.15700.1000 HVAC - Adminstrative Area	**3,135.00 sf**					**101,888**		**32.50 /sf**	**101,888**
0200.15700.2000 Ventilitaton & Fans Process Area									
HVAC System Adminstrative Side	6,650.00 sf				-	36,708	-	5.52 /sf	36,708
0200.15700.2000 Ventilitaton & Fans Process Area	**6,650.00 sf**					**36,708**		**5.52 /sf**	**36,708**
15700 Heating Ventilating and Air Conditioning Equipment		**21**	**889**	**6,750**		**138,596**			**146,235**
16050 Basic Electrical Materials and Methods									
0200.16050.0000 Building Electrical - Power, Lighting & Outlets (Excluding Process Pow									
Building Services Power, Lighting & Outlets	9,938.00 sf				-	298,140	-	30.00 /sf	298,140
0200.16050.0000 Building Electrical - Power, Lighting & Outlets (Excluding Process Pow	**9,938.00 sf**					**298,140**		**30.00 /sf**	**298,140**
16050 Basic Electrical Materials and Methods						**298,140**			**298,140**
0200 OPERATIONS BUILDING		**11,347**	**764,763**	**1,851,839**	**39,734**	**607,869**	**2,208**		**3,266,413**
0300 HIGH SERVICE PUMP STATION									
08300 Specialty Doors									
0300.08300.1010 High Service Pump Station Slab Hatch									
48x48 Stainless Steel Bilco Floor Access Door, Drainage Frame, Pedestrian Loading, Double Leaf, 300psf, Type JD-2	4.00 EA		-	17,960	-	-	-	4,490.00 /EA	17,960
-- Install 48x48 Stainless Steel Bilco Floor Access Door, Drainage Frame, Pedestrian Loading, Double Leaf, 300psf, Type JD-2	4.00 ea	13	879	-	-	-	-	219.72 /ea	879
0300.08300.1010 High Service Pump Station Slab Hatch	**4.00 ea**	**13**	**879**	**17,960**				**4,709.72 /ea**	**18,839**
08300 Specialty Doors		**13**	**879**	**17,960**					**18,839**
11200 Water Supply and Treatment Equipment									
0300.11240.0000 Vertical Turbine Pumps									
Vertical Turbine Pump Line Shaft 100 HP	3.00 ea			195,000			-	65,000.00 /ea	195,000
-- Align & Set Pump w/ Motor	3.00 ea	192	12,683				-	4,227.52 /ea	12,683
0300.11240.0000 Vertical Turbine Pumps	**3.00 ea**	**192**	**12,683**	**195,000**				**69,227.52 /ea**	**207,683**
0300.11240.1000 Vertical Turbine Backwash Pump									
Vertical Turbine Pump Line Shaft 60 HP	1.00 ea			48,000			-	48,000.00 /ea	48,000
-- Align & Set Pump w/ Motor	1.00 ea	64	4,228				-	4,227.52 /ea	4,228
0300.11240.1000 Vertical Turbine Backwash Pump	**1.00 ea**	**64**	**4,228**	**48,000**				**52,227.52 /ea**	**52,228**
10.0300.11240.0000 Lake of Forest Vertical Turbine Pump									
Vertical Turbine Pump Line Shaft 100 HP	1.00 ea			65,000			-	65,000.00 /ea	65,000
-- Align & Set Pump w/ Motor	1.00 ea	64	4,228				-	4,227.52 /ea	4,228
10.0300.11240.0000 Lake of Forest Vertical Turbine Pump	**1.00 ea**	**64**	**4,228**	**65,000**				**69,227.52 /ea**	**69,228**
11200 Water Supply and Treatment Equipment		**320**	**21,138**	**308,000**					**329,138**
13120 Pre-Engineered Metal Building									
0300.13120.0000 Pre-engineered Structure									

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
0300.13120.0000 Pre-engineered Structure									
Pre-Engineered Metal Bldg, Structure (under 5,000 sf)	200.00 sf		-	3,000	-	-	-	15.00 /sf	3,000
-- Install Pre-Engineered Metal Bldg, Structure (under 5,000 sf)	200.00 sf	40	3,119	-	-	-	-	15.59 /sf	3,119
0300.13120.0000 Pre-engineered Structure	200.00 sf	40	3,119	3,000				30.59 /sf	6,119
13120 Pre-Engineered Metal Building		40	3,119	3,000					6,119
15700 Heating Ventilating and Air Conditioning Equipment									
10.0300.15700.0000 HVAC for Pump Station - 20 Ton									
Packaged Unit 20T	1.00 ea		-	25,449	-	-	-	25,449.24 /ea	25,449
-- Install Packaged Unit 20T	1.00 ea	36	3,104	-	-	-	-	3,104.17 /ea	3,104
10.0300.15700.0000 HVAC for Pump Station - 20 Ton	1.00 ea	36	3,104	25,449				28,553.41 /ea	28,553
15700 Heating Ventilating and Air Conditioning Equipment		36	3,104	25,449					28,553
0300 HIGH SERVICE PUMP STATION		**409**	**28,239**	**354,409**					**382,649**
0400 TREATED WATER RESERVOIR									
02300 Earthwork									
0400.02300.0000 Excavate Water Reservoir									
Haul excavated material off-site, 18 cy dump truck, 35 mph average, cycle 40 miles	1,189.17 cy	106	6,612	-	8,494	-	-	12.70 /cy	15,106
Excavate and pile, heavy soil / stiff clay, bulk bank measure, hydraulic excavator, crawler, 3.68 cy bucket	570.13 cy	3	187	-	641	-	-	1.45 /cy	829
Excavate and load onto trucks, heavy soil / stiff clay, bulk bank measure, hydraulic excavator, crawler, 3.68 cy bucket	1,189.17 cy	7	460	-	1,574	-	-	1.71 /cy	2,033
Labor support during excavation	1,759.30 cy	26	1,429	-	-	-	-	0.81 /cy	1,429
Spread off-site stockpile, dozer (D6)	1,189.17 cy	14	881	-	965	-	-	1.55 /cy	1,846
Backfill from excavated pile, hydraulic excavator, crawler, 3.68 cy bucket	570.13 cy	6	375	-	1,283	-	-	2.91 /cy	1,657
Labor support during backfill	570.13 cy	380	19,120	-	-	-	-	33.54 /cy	19,120
Load fill from on-site stockpile onto dump truck, front end loader, wheel mounted, 3 cy bucket	576.70 cy	5	303	-	223	-	-	0.91 /cy	526
Backfill, front end loader, wheel mounted, 3 cy bucket	574.51 cy	6	420	-	308	-	-	1.27 /cy	728
Labor support during backfill	574.51 cy	383	19,267	-	-	-	-	33.54 /cy	19,267
Compact backfill, single drum, padfoot, 8" lift	1,144.64 cy	10	649	-	363	-	-	0.88 /cy	1,012
TRUCK - Water tanker, 2500 gal (Diesel)	29.20 hr	29	1,838	-	784	-	-	89.82 /hr	2,623
0400.02300.0000 Excavate Water Reservoir	2,948.47 cy	975	51,540		14,635			22.44 /cy	66,175
02300 Earthwork		975	51,540		14,635				66,175
02450 Foundations and Load-Bearing Elements									
0400.02450.0000 Sheet Pile Water Reservoir									
Sheet Pile	3,450.00 sf				-	181,125	-	52.50 /sf	181,125
0400.02450.0000 Sheet Pile Water Reservoir	3,450.00 sf					181,125		52.50 /sf	181,125
02450 Foundations and Load-Bearing Elements						181,125			181,125
03300 Concrete, Placement and Finishing									
0400.03300.0000 Reservoir & Pump Station Concrete Mat Foundation									
Import Aggregate Base Fill	89.22 cy		-	1,874	-	1,561	-	38.50 /cy	3,435
Backfill, hydraulic excavator, crawler, 2.50 cy bucket	89.22 cy	9	586	-	1,209	-	-	20.13 /cy	1,796
CRANE - Hydraulic Truck - 81T (Max boom Length 114') w/ Operator	3.00 day	24	1,634	-	3,353	-	-	1,662.36 /day	4,987
Mat Foundation Edge Form Mat'l	416.10 sf		-	208	-	-	-	0.50 /sf	208
Foundation Form Oil & Hardware	416.10 sf		-	208	-	-	-	0.50 /sf	208
-- Fine Grade Foundation	1,606.00 sf	13	712	-	-	-	-	0.44 /sf	712
-- Install Mat Foundation Edge Forms	416.10 sf	83	5,634	-	-	-	-	13.54 /sf	5,634
Mat Foundation Rebar and Accessories/Unload & Store	17.84 ton	6	309	178	104	-	-	33.17 /ton	592
Mat Foundation Rebar	17.84 ton		-	16,952	-	-	-	950.00 /ton	16,952
-- Mat Foundation Rebar	17.84 ton	286	21,053	-	-	-	-	1,179.82 /ton	21,053
4500 psi Concrete	178.44 cy		-	23,198	-	-	-	130.00 /cy	23,198
4500 psi Concrete (Waste)	12.49 cy		-	1,624	-	-	-	130.00 /cy	1,624
Ice Chips	178.44 cy		-	4,461	-	-	-	25.00 /cy	4,461
Place Mat Foundation, Pumped	178.44 cy	89	4,835	-	-	-	-	27.09 /cy	4,835
Float Finish Top of Mat Foundation	1,606.00 sf	13	782	-	-	-	-	0.49 /sf	782
Mat Foundation Concrete Pumping- 170' Boom (52m)	178.44 cy		-	-	-	2,230	714	16.50 /cy	2,944
Water Base Non-Residual Cure	1,606.00 sf	3	195	96	-	-	-	0.18 /sf	292
0400.03300.0000 Reservoir & Pump Station Concrete Mat Foundation	178.44 cy	525	35,740	48,799	4,666	3,791	714	525.17 /cy	93,711
0400.03300.1000 Reservoir & Pump Station Concrete Walls									
Rent Conc.. Wall Gang Forms > 16' tall	4,993.20 sf		-	6,242	-	-	-	1.25 /sf	6,242
-- Assemble and Erect Rented Wall Gang Forms > 16' tall	4,993.20 sf	749	50,701	-	-	-	-	10.15 /sf	50,701
-- Move Wall Gang Forms 20' tall	5.00 move	120	8,124	-	-	-	-	1,624.75 /move	8,124
Bulkheads/Construction Joints/Wall Ends	408.80 sf		-	1,298	-	-	-	3.18 /sf	1,298
-- Install Bulkheads/Construction Joints/Wall Ends	408.80 sf	184	12,454	-	-	-	-	30.46 /sf	12,454
-- Blast Clean Construction Joints	408.80 sf	8	443	172	150	-	-	1.87 /sf	764
Wall Form Oil & Hardware	4,993.20 sf		-	6,491	-	-	-	1.30 /sf	6,491
Wall Rebar and Accessories/Unload & Store	18.49 ton	6	321	185	108	-	-	33.17 /ton	613
Rebar Templates- 1 Use	138.70 lf	139	10,228	104	-	-	-	74.49 /lf	10,332

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
0400.03300.1000 Reservoir & Pump Station Concrete Walls									
Wall Rebar	18.49 ton		-	17,568	-	-	-	950.00 /ton	17,568
-- Install Wall Rebar	18.49 ton	296	21,818	-	-	-	-	1,179.82 /ton	21,818
4500 psi Concrete	184.93 cy		-	24,041	-	-	-	130.00 /cy	24,041
4500 psi Concrete (Waste)	12.95 cy		-	1,683	-	-	-	130.00 /cy	1,683
Ice Chips	184.93 cy		-	4,623	-	-	-	25.00 /cy	4,623
Place Straight Wall, Pumped	184.93 cy	185	10,251	-	18	-	-	55.53 /cy	10,269
Grout Bed for Horiz Const Joint @ Wall	138.70 lf	7	422	67	-	-	-	3.53 /lf	489
Float Finish / Strike-off top of Wall	277.40 sf	2	135	-	-	-	-	0.49 /sf	135
Straight Wall Concrete Pump- 170' Boom (52m)	184.93 cy		-	-	-	4,623	740	29.00 /cy	5,362
Water Base Non-Residual Cure	4,993.20 sf	10	608	300	-	-	-	0.18 /sf	907
Concrete Sealer- Water Based	4,993.20 sf	10	608	649	-	-	-	0.25 /sf	1,257
Point & Patch Wall	4,993.20 sf	100	6,075	50	-	-	-	1.23 /sf	6,125
0400.03300.1000 Reservoir & Pump Station Concrete Walls	**184.93 cy**	**1,815**	**122,186**	**63,473**	**276**	**4,623**	**740**	**1,034.43 /cy**	**191,297**
0400.03300.2000 Reservoir & Pump Station Concrete Separator Walls									
Rent Conc.. Wall Gang Forms > 16' tall	554.80 sf		-	694	-	-	-	1.25 /sf	694
-- Assemble and Erect Rented Wall Gang Forms > 16' tall	554.80 sf	83	5,633	-	-	-	-	10.15 /sf	5,633
-- Move Wall Gang Forms 20' tall	2.00 move	48	3,250	-	-	-	-	1,624.75 /move	3,250
Wall Form Oil & Hardware	554.80 sf		-	721	-	-	-	1.30 /sf	721
Wall Rebar and Accessories/Unload & Store	1.54 ton	0	27	15	9	-	-	33.17 /ton	51
Rebar Templates- 1 Use	14.60 lf	15	1,077	11	-	-	-	74.49 /lf	1,088
Wall Rebar	1.54 ton		-	1,464	-	-	-	950.00 /ton	1,464
-- Install Wall Rebar	1.54 ton	25	1,818	-	-	-	-	1,179.83 /ton	1,818
4500 psi Concrete	15.41 cy		-	2,003	-	-	-	130.00 /cy	2,003
4500 psi Concrete (Waste)	1.08 cy		-	140	-	-	-	130.00 /cy	140
Ice Chips	15.41 cy		-	385	-	-	-	25.00 /cy	385
Place Straight Wall, Pumped	15.41 cy	19	1,068	-	2	-	-	69.41 /cy	1,070
Float Finish / Strike-off top of Wall	21.90 sf	0	11	-	-	-	-	0.49 /sf	11
Straight Wall Concrete Pump- 170' Boom (52m)	15.41 cy		-	-	-	642	62	45.67 /cy	704
Water Base Non-Residual Cure	554.80 sf	1	68	33	-	-	-	0.18 /sf	101
Point & Patch Wall	554.80 sf	11	675	6	-	-	-	1.23 /sf	681
0400.03300.2000 Reservoir & Pump Station Concrete Separator Walls	**15.41 cy**	**203**	**13,625**	**5,473**	**11**	**642**	**62**	**1,285.71 /cy**	**19,813**
0400.03300.3000 Reservoir Top Slab - 18"									
CRANE - Hydraulic Truck - 136T (Max boom Length 160') w/ Operator	3.00 day	24	1,634	-	5,295	-	-	2,309.54 /day	6,929
Suspended Slab Form Mat'l > 15' high	1,693.60 sf		-	1,694	-	-	-	1.00 /sf	1,694
Slab Edge Form Mat'l > 1' thick	214.62 sf		-	537	-	-	-	2.50 /sf	537
Elevated Slab Form Oil & Hardware	1,908.22 sfca		-	954	-	-	-	0.50 /sfca	954
-- Install Suspended Slab Forms > 15' high	1,693.60 sf	423	28,663	-	-	-	-	16.92 /sf	28,663
-- Install Slab Edge Form > 1' thick	214.62 sf	54	3,632	-	-	-	-	16.93 /sf	3,632
Rent Slab Shore Sys- 18" Slab Soffit x 20 Ft AFF	1,693.60 sfmo		-	-	-	5,081	-	3.00 /sfmo	5,081
-- Install Rented Shore Sys- 18" Slab Soffit x 20 Ft AFF	1,693.60 sf	110	7,452	-	-	-	-	4.40 /sf	7,452
Elevated Slab Rebar and Accessories/Unload & Store	9.41 ton	3	163	94	55	-	-	33.17 /ton	312
Elevated Slab Rebar	9.41 ton		-	8,939	-	-	-	950.00 /ton	8,939
-- Install Elevated Slab Rebar	9.41 ton	151	11,101	-	-	-	-	1,179.82 /ton	11,101
4500 psi Concrete	94.09 cy		-	12,232	-	-	-	130.00 /cy	12,232
4500 psi Concrete (Waste)	6.59 cy		-	856	-	-	-	130.00 /cy	856
Ice Chips	94.09 cy		-	2,352	-	-	-	25.00 /cy	2,352
Place Elevated Slab, Pumped	94.09 cy	71	3,824	-	-	-	-	40.64 /cy	3,824
Float Finish Elevated Slab	1,693.60 sf	14	824	-	-	-	-	0.49 /sf	824
Elevated Slab Concrete Pump- 180' Boom (55m)	94.09 cy		-	-	-	1,512	235	18.57 /cy	1,747
Burlap Blanket & Water Cure 4 Use	1,693.60 sf	8	515	41	-	-	-	0.33 /sf	556
Concrete Sealer- Water Based	1,693.60 sf	3	206	220	-	-	-	0.25 /sf	426
0400.03300.3000 Reservoir Top Slab - 18"	**94.09 cy**	**861**	**58,015**	**27,918**	**5,349**	**6,593**	**235**	**1,042.73 /cy**	**98,111**
03300 Concrete, Placement and Finishing		**3,404**	**229,567**	**145,663**	**10,302**	**15,649**	**1,750**		**402,932**
08300 Specialty Doors									
0400.08300.1010 Treated Water Reservoir Slab Hatch									
48x48 Stainless Steel Bilco Floor Access Door, Drainage Frame, Pedestrian Loading, Double Leaf, 300psf, Type JD-2	2.00 EA		-	8,980	-	-	-	4,490.00 /EA	8,980
-- Install 48x48 Stainless Steel Bilco Floor Access Door, Drainage Frame, Pedestrian Loading, Double Leaf, 300psf, Type JD-2	2.00 ea	6	439	-	-	-	-	219.72 /ea	439
0400.08300.1010 Treated Water Reservoir Slab Hatch	**2.00 ea**	**6**	**439**	**8,980**				**4,709.72 /ea**	**9,419**
08300 Specialty Doors		**6**	**439**	**8,980**					**9,419**
0400 TREATED WATER RESERVOIR		**4,386**	**281,547**	**154,643**	**24,938**	**196,774**	**1,750**		**659,652**
0500 RECARBINATION BASIN									
02300 Earthwork									
0500.02300.0000 Excavate Backfill CO2 Basin									

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
0500.02300.0000 Excavate Backfill CO2 Basin									
Haul fill from on-site stockpile, 18 cy dump truck, 15 mph average, cycle 1 miles	216.75 cy	5	298	-	383	-	-	3.14 /cy	681
Excavate and load onto trucks, heavy soil / stiff clay, bulk bank measure, hydraulic excavator, crawler, 2.50 cy bucket	364.80 cy	3	218	-	449	-	-	1.83 /cy	667
Labor support during excavation	364.68 cy	5	296	-	-	-	-	0.81 /cy	296
Haul spoils to on-site stockpile, 18 cy dump truck, 15 mph average, cycle 1 miles	364.80 cy	4	229	-	294	-	-	1.43 /cy	522
Spread on-site stockpile, dozer (D6)	364.80 cy	4	270	-	296	-	-	1.55 /cy	566
Load fill from on-site stockpile onto dump truck, backhoe / loader, 3/4 cy bucket	216.75 cy	5	300	-	160	-	-	2.12 /cy	460
Backfill, backhoe / loader, 3/4 cy bucket	216.00 cy	7	453	-	241	-	-	3.22 /cy	695
Labor support during backfill	216.00 cy	7	362	-	-	-	-	1.68 /cy	362
Compact backfill around a building foundation, 8" lifts, walk behind 21" x 24" vibratory plate compactor	216.00 cy	43	2,340	-	123	-	-	11.40 /cy	2,462
TRUCK - Water tanker, 2500 gal (Diesel)	24.00 hr	24	1,511	-	645	-	-	89.82 /hr	2,156
0500.02300.0000 Excavate Backfill CO2 Basin	**581.55 cy**	**108**	**6,277**		**2,591**			**15.25 /cy**	**8,868**
02300 Earthwork		**108**	**6,277**		**2,591**				**8,868**
02450 Foundations and Load-Bearing Elements									
0500.02450.0000 Sheetpile CO2 Contactor Basin									
Sheet Pile	1,206.00 sf				-	63,315	-	52.50 /sf	63,315
0500.02450.0000 Sheetpile CO2 Contactor Basin	**1,206.00 sf**					**63,315**		**52.50 /sf**	**63,315**
02450 Foundations and Load-Bearing Elements						**63,315**			**63,315**
03300 Concrete, Placement and Finishing									
0500.03300.0010 Recarbination Basin Slab 18"									
Import Aggregate Base Fill	10.70 cy		-	161	-		-	15.00 /cy	161
Backfill, hydraulic excavator, crawler, 2.50 cy bucket	10.70 cy	0	12	-	24	-	-	3.35 /cy	36
CRANE - Hydraulic Truck - 136T (Max boom Length 160') w/ Operator	0.25 day	2	136	-	441	-	-	2,309.56 /day	577
-- Fine Grade Foundation	289.00 sf	2	128	-	-	-	-	0.44 /sf	128
Slab-on-Grade (Edge Form Mat'l), 1-Use	102.00 sf		-	337	-	-	-	3.30 /sf	337
-- Install Slab-on-Grade (Edge Forms), 1-Use	102.00 sf	26	1,726	-	-	-	-	16.93 /sf	1,726
SOG Form Oil & Hardware	102.00 sf		-	51	-	-	-	0.50 /sf	51
SOG Rebar and Accessories/Unload & Store	1.61 ton	1	28	16	9	-	-	33.16 /ton	53
SOG Rebar	1.61 ton		-	1,526	-	-	-	950.00 /ton	1,526
-- Install SOG Rebar	1.61 ton	26	1,895	-	-	-	-	1,179.83 /ton	1,895
4500 psi Concrete	16.06 cy		-	2,087	-	-	-	130.00 /cy	2,087
4500 psi Concrete (Waste)	1.12 cy		-	146	-	-	-	130.00 /cy	146
Ice Chips	16.06 cy		-	401	-	-	-	25.00 /cy	401
Place SOG, Pumped	16.06 cy	11	580	-	-	-	-	36.11 /cy	580
Float Finish SOG	289.00 sf	2	141	-	-	-	-	0.49 /sf	141
SOG Concrete Pump- 170' Boom (52m)	16.06 cy		-	-	-	209	40	15.50 /cy	249
Burlap Blanket & Water Cure 4 Use	289.00 sf	1	88	7	-	-	-	0.33 /sf	95
0500.03300.0010 Recarbination Basin Slab 18"	**16.06 cy**	**71**	**4,733**	**4,732**	**475**	**209**	**40**	**634.41 /cy**	**10,189**
0500.03300.1010 Recarbination Basin Walls 18"									
CRANE - Hydraulic Truck - 136T (Max boom Length 160') w/ Operator	0.50 day	4	272	-	882	-	-	2,309.54 /day	1,155
Wall Form Mat'l - Lumber 8' tall 1-Use	680.00 sf		-	2,947	-	-	-	4.33 /sf	2,947
-- Build and Erect Wall Forms - Lumber 8' tall 1-Use	680.00 sf	122	8,286	-	-	-	-	12.19 /sf	8,286
Wall Form Oil & Hardware	680.00 sf		-	884	-	-	-	1.30 /sf	884
Wall Rebar and Accessories/Unload & Store	1.89 ton	1	33	19	11	-	-	33.17 /ton	63
Wall Rebar	1.89 ton		-	1,795	-	-	-	950.00 /ton	1,795
-- Install Wall Rebar	1.89 ton	30	2,229	-	-	-	-	1,179.83 /ton	2,229
4500 psi Concrete	18.89 cy		-	2,456	-	-	-	130.00 /cy	2,456
4500 psi Concrete (Waste)	1.32 cy		-	172	-	-	-	130.00 /cy	172
Ice Chips	18.89 cy		-	472	-	-	-	25.00 /cy	472
Place Straight Wall, Pumped	18.89 cy	31	1,745	-	3	-	-	92.54 /cy	1,748
Float Finish / Strike-off top of Wall	102.00 sf	1	50	-	-	-	-	0.49 /sf	50
Straight Wall Concrete Pump- 170' Boom (52m)	18.89 cy		-	-	-	614	47	35.00 /cy	661
Burlap Blanket & Water Cure 4 Use	680.00 sf	7	414	16	-	-	-	0.63 /sf	430
Concrete Sealer- Water Based	680.00 sf	1	83	88	-	-	-	0.25 /sf	171
Point & Patch Wall	680.00 sf	14	827	7	-	-	-	1.23 /sf	834
0500.03300.1010 Recarbination Basin Walls 18"	**18.89 cy**	**211**	**13,938**	**8,856**	**897**	**614**	**47**	**1,289.15 /cy**	**24,352**
0500.03300.1020 Recarbination Basin Slab Top 12"									
CRANE - Hydraulic Truck - 136T (Max boom Length 160') w/ Operator	0.25 day	2	136	-	441	-	-	2,309.56 /day	577
Suspended Slab Form Mat'l 0 - 15' high	289.00 sf		-	289	-	-	-	1.00 /sf	289
Floor Opening Form Mat'l	16.00 lf		-	8	-	-	-	0.50 /lf	8
Slab Edge Form Mat'l <= 1' thick	68.00 sf		-	136	-	-	-	2.00 /sf	136
Elevated Slab Form Oil & Hardware	373.00 sfca		-	187	-	-	-	0.50 /sfca	187
-- Install Suspended Slab Forms 0 - 15' high	289.00 sf	72	4,891	-	-	-	-	16.92 /sf	4,891
-- Install Floor Opening Forms	16.00 lf	4	271	-	-	-	-	16.92 /lf	271
-- Install Slab Edge Form <= 1' thick	68.00 sf	17	1,151	-	-	-	-	16.93 /sf	1,151

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
0500.03300.1020 Recarbination Basin Slab Top 12"									
Rent Slab Shore Sys- 12" Slab Soffit x 8 Ft AFF	289.00 sfmo		-	-	-	867	-	3.00 /sfmo	867
-- Install Rented Shore Sys- 12" Slab Soffit x 8 Ft AFF	289.00 sf	19	1,272	-	-	-	-	4.40 /sf	1,272
Elevated Slab Rebar and Accessories/Unload & Store	1.07 ton	0	19	11	6	-	-	33.16 /ton	35
Elevated Slab Rebar	1.07 ton		-	1,017	-	-	-	950.00 /ton	1,017
-- Install Elevated Slab Rebar	1.07 ton	17	1,262	-	-	-	-	1,179.82 /ton	1,262
4500 psi Concrete	10.70 cy		-	1,392	-	-	-	130.00 /cy	1,392
4500 psi Concrete (Waste)	0.75 cy		-	97	-	-	-	130.00 /cy	97
Ice Chips	10.70 cy		-	268	-	-	-	25.00 /cy	268
Place Elevated Slab, Pumped	10.70 cy	17	969	-	-	-	-	90.52 /cy	969
Float Finish Elevated Slab	289.00 sf	2	141	-	-	-	-	0.49 /sf	141
Elevated Slab Concrete Pump- 170' Boom (52m)	10.70 cy		-	-	-	348	27	35.00 /cy	375
Burlap Blanket & Water Cure 4 Use	289.00 sf	1	88	7	-	-	-	0.33 /sf	95
Concrete Sealer- Water Based	289.00 sf	1	35	38	-	-	-	0.25 /sf	73
0500.03300.1020 Recarbination Basin Slab Top 12"	**10.70 cy**	**153**	**10,234**	**3,448**	**447**	**1,215**	**27**	**1,436.55 /cy**	**15,371**
0500.03300.1030 Recarbination Basin Mixing Chamber									
Import Aggregate Base Fill	0.78 cy		-	12	-		-	15.00 /cy	12
CRANE - Hydraulic Truck - 136T (Max boom Length 160') w/ Operator	0.25 day	2	136	-	441	-	-	2,309.56 /day	577
CRANE - Hydraulic Truck - 136T (Max boom Length 160') w/ Operator	0.25 day	2	136	-	441	-	-	2,309.56 /day	577
CRANE - Hydraulic Truck - 136T (Max boom Length 160') w/ Operator	0.25 day	2	136	-	441	-	-	2,309.56 /day	577
-- Fine Grade Foundation	42.25 sf	0	19	-	-	-	-	0.44 /sf	19
Slab-on-Grade (Edge Form Mat'l), 1-Use	19.50 sf		-	64	-	-	-	3.30 /sf	64
-- Install Slab-on-Grade (Edge Forms), 1-Use	19.50 sf	5	330	-	-	-	-	16.93 /sf	330
SOG Form Oil & Hardware	19.50 sf		-	10	-	-	-	0.50 /sf	10
SOG Rebar and Accessories/Unload & Store	0.14 ton	0	2	1	1	-	-	33.14 /ton	5
SOG Rebar	0.14 ton		-	130	-	-	-	950.00 /ton	130
-- Install SOG Rebar	0.14 ton	2	162	-	-	-	-	1,179.85 /ton	162
4500 psi Concrete	1.57 cy		-	203	-	-	-	130.00 /cy	203
4500 psi Concrete (Waste)	0.11 cy		-	14	-	-	-	130.00 /cy	14
Ice Chips	1.57 cy		-	39	-	-	-	25.00 /cy	39
Place SOG, Pumped	1.57 cy	2	88	-	-	-	-	56.44 /cy	88
Float Finish SOG	42.25 sf	0	21	-	-	-	-	0.49 /sf	21
SOG Concrete Pump- 170' Boom (52m)	1.57 cy		-	-	-	12	4	10.30 /cy	16
Burlap Blanket & Water Cure 4 Use	42.25 sf	0	13	1	-	-	-	0.33 /sf	14
Wall Form Mat'l - Lumber 4' tall 1-Use	156.00 sf		-	712	-	-	-	4.57 /sf	712
-- Build and Erect Wall Forms - Lumber 4' tall 1-Use	156.00 sf	28	1,901	-	-	-	-	12.19 /sf	1,901
Wall Form Oil & Hardware	156.00 sf		-	203	-	-	-	1.30 /sf	203
Wall Rebar and Accessories/Unload & Store	0.17 ton	0	3	2	1	-	-	33.20 /ton	6
Wall Rebar	0.17 ton		-	161	-	-	-	950.00 /ton	161
-- Install Wall Rebar	0.17 ton	3	199	-	-	-	-	1,179.80 /ton	199
4500 psi Concrete	1.93 cy		-	250	-	-	-	130.00 /cy	250
4500 psi Concrete (Waste)	0.14 cy		-	18	-	-	-	130.00 /cy	18
Ice Chips	1.93 cy		-	48	-	-	-	25.00 /cy	48
Place Straight Wall, Pumped	1.93 cy	3	178	-	0	-	-	92.57 /cy	178
Float Finish / Strike-off top of Wall	13.00 sf	0	6	-	-	-	-	0.49 /sf	6
Straight Wall Concrete Pump- 170' Boom (52m)	1.93 cy		-	-	-	63	5	35.01 /cy	67
Burlap Blanket & Water Cure 4 Use	156.00 sf	2	95	4	-	-	-	0.63 /sf	99
Concrete Sealer- Water Based	156.00 sf	0	19	20	-	-	-	0.25 /sf	39
Point & Patch Wall	156.00 sf	3	190	2	-	-	-	1.23 /sf	191
Suspended Slab Form Mat'l 0 - 15' high	42.25 sf		-	42	-	-	-	1.00 /sf	42
Slab Edge Form Mat'l <= 1' thick	13.00 sf		-	26	-	-	-	2.00 /sf	26
Elevated Slab Form Oil & Hardware	55.25 sfca		-	28	-	-	-	0.50 /sfca	28
-- Install Suspended Slab Forms 0 - 15' high	42.25 sf	11	715	-	-	-	-	16.92 /sf	715
-- Install Slab Edge Form <= 1' thick	13.00 sf	3	220	-	-	-	-	16.93 /sf	220
Rent Slab Shore Sys- 8" Slab Soffit x 8 Ft AFF	42.25 sfmo		-	-	-	127	-	3.00 /sfmo	127
-- Install Rented Shore Sys- 8" Slab Soffit x 8 Ft AFF	42.25 sf	3	186	-	-	-	-	4.40 /sf	186
Elevated Slab Rebar and Accessories/Unload & Store	0.09 ton	0	2	1	1	-	-	33.19 /ton	3
Elevated Slab Rebar	0.09 ton		-	86	-	-	-	950.00 /ton	86
-- Install Elevated Slab Rebar	0.09 ton	1	107	-	-	-	-	1,179.80 /ton	107
4500 psi Concrete	1.04 cy		-	136	-	-	-	130.00 /cy	136
4500 psi Concrete (Waste)	0.07 cy		-	9	-	-	-	130.00 /cy	9
Ice Chips	1.04 cy		-	5	-	-	-	5.01 /cy	5
Place Elevated Slab, Pumped	1.04 cy	1	70	-	-	-	-	67.57 /cy	70
Float Finish Elevated Slab	42.25 sf	0	21	-	-	-	-	0.49 /sf	21
Elevated Slab Concrete Pump- 170' Boom (52m)	1.04 cy		-	-	-	25	3	26.87 /cy	28
Burlap Blanket & Water Cure 4 Use	42.25 sf	0	13	1	-	-	-	0.33 /sf	14

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
0500.03300.1030 Recarbination Basin Mixing Chamber									
Concrete Sealer- Water Based	42.25 sf	0	5	5	-	-	-	0.25 /sf	11
0500.03300.1030 Recarbination Basin Mixing Chamber	4.54 cy	75	4,973	2,234	1,326	227	11	1,932.21 /cy	8,772
03300 Concrete, Placement and Finishing		510	33,879	19,270	3,145	2,264	125		58,684
08300 Specialty Doors									
0500.08300.1010 Recarbination Basin Slab Hatch									
48x48 Stainless Steel Bilco Floor Access Door, Drainage Frame, Pedestrian Loading, Double Leaf, 300psf, Type JD-2	1.00 EA		-	4,490	-	-	-	4,490.00 /EA	4,490
-- Install 48x48 Stainless Steel Bilco Floor Access Door, Drainage Frame, Pedestrian Loading, Double Leaf, 300psf, Type JD-2	1.00 ea	3	220	-	-	-	-	219.72 /ea	220
0500.08300.1010 Recarbination Basin Slab Hatch	1.00 ea	3	220	4,490				4,709.72 /ea	4,710
08300 Specialty Doors		3	220	4,490					4,710
0500 RECARBINATION BASIN		**621**	**40,376**	**23,760**	**5,736**	**65,579**	**125**		**135,576**
0600 PROCESS ELECTRICAL & INSTRUMENTATION									
16050 Basic Electrical Materials and Methods									
0600.16050.0000 Electrical & Instrumentation									
Electrical & Instrumentation For Process Work	9,938.00 sf	2,485	144,655	372,675	-	-	-	52.06 /sf	517,330
0600.16050.0000 Electrical & Instrumentation	9,938.00 sf	2,485	144,655	372,675				52.06 /sf	517,330
16050 Basic Electrical Materials and Methods		2,485	144,655	372,675					517,330
0600 PROCESS ELECTRICAL & INSTRUMENTATION		**2,485**	**144,655**	**372,675**					**517,330**
0700 YARD PIPING									
02300 Earthwork									
0700.02300.0000 20" Influent Flow Meter Vault Excavation Backfill									
Excavate and pile, heavy soil / stiff clay, bulk bank measure, hydraulic excavator, crawler, 2.50 cy bucket	32.00 cy	0	32	-	67	-	-	3.10 /cy	99
Labor support during excavation	32.00 cy	0	27	-	-	-	-	0.83 /cy	27
Backfill, front end loader, wheel mounted, 3 cy bucket	18.00 cy	2	118	-	87	-	-	11.40 /cy	205
Labor support during backfill	18.00 cy	4	181	-	-	-	-	10.06 /cy	181
Compact backfill around a building foundation, 8" lifts, walk behind 21" x 24" vibratory plate compactor	18.00 cy	7	390	-	20	-	-	22.80 /cy	410
0700.02300.0000 20" Influent Flow Meter Vault Excavation Backfill	32.00 cy	14	748		174			28.83 /cy	922
02300 Earthwork		14	748		174				922
02500 Buried Piping									
0700.02510.1000 20" DIP Influent Piping - Incl Fittings & Valves									
-- Unload, Stage & String Pipe - 20"	442.00 lf	6	338	-	142	-	-	1.09 /lf	480
-- Excavate, Lay & Backfill Pipe - Shored Trench - 20" (4'-8' Depth)	442.00 lf	77	4,364	-	1,946	-	-	14.28 /lf	6,309
-- Disinfect & Sample Test Pipe, 20"	442.00 lf	12	640	-	144	-	-	1.77 /lf	784
20" DI Mortar-Lined, Restrained Joint, Class 53, Pipe w/Fittings	442.00 LF		-	78,090	-	-	-	176.68 /LF	78,090
0700.02510.1000 20" DIP Influent Piping - Incl Fittings & Valves	442.00 lf	95	5,342	78,090	2,232			193.81 /lf	85,664
0700.02510.1010 20" DIP Filter Backwash Drain									
-- Unload, Stage & String Pipe - 20"	63.00 lf	1	48	-	20	-	-	1.09 /lf	68
-- Excavate, Lay & Backfill Pipe - Shored Trench - 20" (4'-8' Depth)	63.00 lf	11	622	-	277	-	-	14.28 /lf	899
-- Disinfect & Sample Test Pipe, 20"	63.00 lf	2	91	-	20	-	-	1.77 /lf	112
20" DI Mortar-Lined, Push-On, Class 53, Pipe w/Fittings	63.00 LF		-	6,317	-	-	-	100.28 /LF	6,317
0700.02510.1010 20" DIP Filter Backwash Drain	63.00 lf	14	761	6,317	318			117.41 /lf	7,397
0700.02510.1020 20" DIP Filter Backwash Supply - Incl Fittings & Valves									
-- Unload, Stage & String Pipe - 20"	207.00 lf	3	158	-	67	-	-	1.09 /lf	225
-- Excavate, Lay & Backfill Pipe - Shored Trench - 20" (4'-8' Depth)	207.00 lf	36	2,044	-	911	-	-	14.27 /lf	2,955
-- Disinfect & Sample Test Pipe, 20"	207.00 lf	6	300	-	67	-	-	1.77 /lf	367
20" DI Mortar-Lined, Restrained Joint, Class 53, Pipe w/Fittings	207.00 LF		-	36,572	-	-	-	176.68 /LF	36,572
0700.02510.1020 20" DIP Filter Backwash Supply - Incl Fittings & Valves	207.00 lf	45	2,502	36,572	1,045			193.81 /lf	40,119
0700.02510.1030 14" DIP Filter Discharge									
-- Unload, Stage & String Pipe - 14"	180.00 lf	2	115	-	48	-	-	0.91 /lf	163
-- Excavate, Lay & Backfill Pipe - Shored Trench - 14" (4'-8' Depth)	180.00 lf	23	1,292	-	576	-	-	10.38 /lf	1,869
-- Disinfect & Sample Test Pipe, 14"	180.00 lf	4	195	-	44	-	-	1.33 /lf	239
14" DI Mortar-Lined, Restrained Joint, Class 53, Pipe w/Fittings	180.00 LF		-	14,153	-	-	-	78.63 /LF	14,153
0700.02510.1030 14" DIP Filter Discharge	180.00 lf	29	1,603	14,153	668			91.24 /lf	16,424
0700.02510.1040 20" DIP Influent to Clarifiers - Incl Fittings & Valves									
-- Unload, Stage & String Pipe - 20"	30.00 lf	0	23	-	10	-	-	1.09 /lf	33
-- Excavate, Lay & Backfill Pipe - Shored Trench - 20" (4'-8' Depth)	30.00 lf	5	296	-	132	-	-	14.28 /lf	428
-- Disinfect & Sample Test Pipe, 20"	30.00 lf	1	43	-	10	-	-	1.77 /lf	53
20" DI Mortar-Lined, Restrained Joint, Class 53, Pipe w/Fittings	30.00 LF		-	5,300	-	-	-	176.68 /LF	5,300
0700.02510.1040 20" DIP Influent to Clarifiers - Incl Fittings & Valves	30.00 lf	6	363	5,300	151			193.81 /lf	5,814
0700.02510.1050 20" DIP Influent to Future Clarifier - Incl Fittings & Valves									
-- Unload, Stage & String Pipe - 20"	15.00 lf	0	11	-	5	-	-	1.09 /lf	16
-- Excavate, Lay & Backfill Pipe - Shored Trench - 20" (4'-8' Depth)	15.00 lf	3	148	-	66	-	-	14.28 /lf	214

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
0700.02510.1050 20" DIP Influent to Future Clarifier - Incl Fittings & Valves									
-- Disinfect & Sample Test Pipe, 20"	15.00 lf	0	22	-	5	-	-	1.77 /lf	27
20" DI Mortar-Lined, Restrained Joint, Class 53, Pipe w/Fittings	15.00 LF		-	2,650	-	-	-	176.68 /LF	2,650
0700.02510.1050 20" DIP Influent to Future Clarifier - Incl Fittings & Valves	**15.00 lf**	**3**	**181**	**2,650**	**76**			**193.81 /lf**	**2,907**
0700.02510.1060 20" DIP Influent From Recarbination Basin - Incl Fittings & Valves									
-- Unload, Stage & String Pipe - 20"	82.00 lf	1	63	-	26	-	-	1.09 /lf	89
-- Excavate, Lay & Backfill Pipe - Shored Trench - 20" (4'-8' Depth)	82.00 lf	14	810	-	361	-	-	14.28 /lf	1,171
-- Disinfect & Sample Test Pipe, 20"	82.00 lf	2	119	-	27	-	-	1.77 /lf	145
20" DI Mortar-Lined, Restrained Joint, Class 53, Pipe w/Fittings	82.00 LF		-	14,487	-	-	-	176.68 /LF	14,487
0700.02510.1060 20" DIP Influent From Recarbination Basin - Incl Fittings & Valves	**82.00 lf**	**18**	**991**	**14,487**	**414**			**193.81 /lf**	**15,892**
0700.02510.1070 20" DIP Influent Clarifiers to Recarbination Basin - Incl Fittings & V									
-- Unload, Stage & String Pipe - 20"	140.00 lf	2	107	-	45	-	-	1.09 /lf	152
-- Excavate, Lay & Backfill Pipe - Shored Trench - 20" (4'-8' Depth)	140.00 lf	25	1,382	-	616	-	-	14.28 /lf	1,998
-- Disinfect & Sample Test Pipe, 20"	140.00 lf	4	203	-	46	-	-	1.77 /lf	248
20" DI Mortar-Lined, Restrained Joint, Class 53, Pipe w/Fittings	140.00 LF		-	24,735	-	-	-	176.68 /LF	24,735
0700.02510.1070 20" DIP Influent Clarifiers to Recarbination Basin - Incl Fittings & V	**140.00 lf**	**30**	**1,692**	**24,735**	**707**			**193.81 /lf**	**27,133**
0700.02510.1080 20" DIP Influent Future Clarifiet to Recarbination Basin - Incl Fittin									
-- Unload, Stage & String Pipe - 20"	7.00 lf	0	5	-	2	-	-	1.09 /lf	8
-- Excavate, Lay & Backfill Pipe - Shored Trench - 20" (4'-8' Depth)	7.00 lf	1	69	-	31	-	-	14.27 /lf	100
-- Disinfect & Sample Test Pipe, 20"	7.00 lf	0	10	-	2	-	-	1.77 /lf	12
20" DI Mortar-Lined, Restrained Joint, Class 53, Pipe w/Fittings	7.00 LF		-	1,237	-	-	-	176.68 /LF	1,237
0700.02510.1080 20" DIP Influent Future Clarifiet to Recarbination Basin - Incl Fittin	**7.00 lf**	**2**	**85**	**1,237**	**35**			**193.81 /lf**	**1,357**
0700.02510.1090 16" DIP Clarifiers to Lime Residual Faciluty									
-- Unload, Stage & String Pipe - 16"	600.00 lf	7	382	-	161	-	-	0.91 /lf	543
-- Excavate, Lay & Backfill Pipe - Shored Trench - 16" (8'-12' Depth)	600.00 lf	168	9,478	-	4,226	-	-	22.84 /lf	13,704
16" DI Epoxy-Lined, Push-On, Class 53, Pipe w/Fittings	600.00 LF		-	61,572	-	-	-	102.62 /LF	61,572
0700.02510.1090 16" DIP Clarifiers to Lime Residual Faciluty	**600.00 lf**	**175**	**9,860**	**61,572**	**4,387**			**126.37 /lf**	**75,819**
0700.02510.1100 Miscellaneous Chemical Duct Banks									
-- Unload, Stage & String Pipe - Containment Pipe	1,400.00 lf	14	803	-	338	-	-	0.82 /lf	1,141
-- Excavate, Lay & Backfill Pipe - Shored Trench - 8" (8'-12' Depth)	1,400.00 lf	245	13,822	-	6,163	-	-	14.28 /lf	19,984
Containment Pipe	1,400.00 LF		-	71,841	-	-	-	51.32 /LF	71,841
0700.02510.1100 Miscellaneous Chemical Duct Banks	**1,400.00 lf**	**259**	**14,625**	**71,841**	**6,501**			**66.41 /lf**	**92,966**
02500 Buried Piping		**674**	**38,004**	**316,954**	**16,534**				**371,492**
03300 Concrete, Placement and Finishing									
0700.03300.0000 20" Influent Flow Meter Vault Slab on Grade									
Import Aggregate Base Fill	1.19 cy		-	18	-		-	15.00 /cy	18
Backfill, front end loader, wheel mounted, 5 cy bucket	1.19 cy	0	1	-	0	-	-	0.81 /cy	1
CRANE - Hydraulic Truck - 136T (Max boom Length 160') w/ Operator	0.25 day	2	136	-	441	-	-	2,309.56 /day	577
-- Fine Grade Foundation	64.00 sf	1	28	-	-	-	-	0.44 /sf	28
Slab-on-Grade (Edge Form Mat'l), 1-Use	32.00 sf		-	106	-	-	-	3.30 /sf	106
-- Install Slab-on-Grade (Edge Forms), 1-Use	32.00 sf	8	542	-	-	-	-	16.92 /sf	542
SOG Form Oil & Hardware	32.00 sf		-	16	-	-	-	0.50 /sf	16
SOG Rebar and Accessories/Unload & Store	0.21 ton	0	4	2	1	-	-	33.20 /ton	7
SOG Rebar	0.21 ton		-	197	-	-	-	950.00 /ton	197
-- Install SOG Rebar	0.21 ton	3	244	-	-	-	-	1,179.80 /ton	244
4500 psi Concrete	2.37 cy		-	308	-	-	-	130.00 /cy	308
4500 psi Concrete (Waste)	0.17 cy		-	22	-	-	-	130.00 /cy	22
Ice Chips	2.37 cy		-	59	-	-	-	25.00 /cy	59
Place SOG, Pumped	2.37 cy	2	128	-	-	-	-	54.19 /cy	128
Float Finish SOG	64.00 sf	1	31	-	-	-	-	0.49 /sf	31
SOG Concrete Pump- 170' Boom (52m)	2.37 cy		-	-	-	46	6	22.00 /cy	52
Burlap Blanket & Water Cure 4 Use	64.00 sf	0	19	2	-	-	-	0.33 /sf	21
0700.03300.0000 20" Influent Flow Meter Vault Slab on Grade	**2.37 cy**	**17**	**1,134**	**729**	**443**	**46**	**6**	**994.56 /cy**	**2,357**
0700.03300.1000 20" Influent Flow Meter Vault Walls									
Wall Form Mat'l - Lumber 8' tall 1-Use	384.00 sf		-	1,664	-	-	-	4.33 /sf	1,664
-- Build and Erect Wall Forms - Lumber 8' tall 1-Use	384.00 sf	38	2,600	-	-	-	-	6.77 /sf	2,600
Keyway 4"	32.00 lf		-	11	-	-	-	0.35 /lf	11
-- Install Keyway 4"	32.00 lf	0	33	-	-	-	-	1.02 /lf	33
Wall Form Oil & Hardware	394.67 sf		-	513	-	-	-	1.30 /sf	513
Wall Rebar and Accessories/Unload & Store	0.42 ton	0	7	4	2	-	-	33.16 /ton	14
Rebar Templates- 1 Use	32.00 lf	8	590	24	-	-	-	19.19 /lf	614
Wall Rebar	0.42 ton		-	394	-	-	-	950.00 /ton	394
-- Install Wall Rebar	0.42 ton	7	490	-	-	-	-	1,179.83 /ton	490
4500 psi Concrete	4.74 cy		-	616	-	-	-	130.00 /cy	616
4500 psi Concrete (Waste)	0.33 cy		-	43	-	-	-	130.00 /cy	43

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
0700.03300.1000 20" Influent Flow Meter Vault Walls									
Ice Chips	4.74 cy		-	119	-	-	-	25.00 /cy	119
Place Straight Wall, Pumped	4.74 cy	12	657	-	1	-	-	138.82 /cy	658
Float Finish / Strike-off top of Wall	21.33 sf	0	10	-	-	-	-	0.49 /sf	10
Straight Wall Concrete Pump- 170' Boom (52m)	4.74 cy		-	-	-	231	12	51.25 /cy	243
Burlap Blanket & Water Cure 4 Use	384.00 sf	4	234	9	-	-	-	0.63 /sf	243
Concrete Sealer- Water Based	384.00 sf	1	47	50	-	-	-	0.25 /sf	97
Point & Patch Wall	384.00 sf	8	467	4	-	-	-	1.23 /sf	471
0700.03300.1000 20" Influent Flow Meter Vault Walls	**4.74 cy**	**78**	**5,134**	**3,452**	**4**	**231**	**12**	**1,863.37 /cy**	**8,832**
0700.03300.2000 20" Influent Flow Meter Vault Top Slab									
Suspended Slab Form Mat'l 0 - 15' high	64.00 sf		-	64	-	-	-	1.00 /sf	64
Floor Opening Form Mat'l	16.00 lf		-	8	-	-	-	0.50 /lf	8
Slab Edge Form Mat'l <= 1' thick	32.00 sf		-	64	-	-	-	2.00 /sf	64
Elevated Slab Form Oil & Hardware	112.00 sfca		-	56	-	-	-	0.50 /sfca	56
-- Install Suspended Slab Forms 0 - 15' high	64.00 sf	8	542	-	-	-	-	8.46 /sf	542
-- Install Floor Opening Forms	16.00 lf	1	90	-	-	-	-	5.64 /lf	90
-- Install Slab Edge Form <= 1' thick	32.00 sf	4	271	-	-	-	-	8.46 /sf	271
Rent Slab Shore Sys- 12" Slab Soffit x 8 Ft AFF	64.00 sfmo		-	-	-	192	-	3.00 /sfmo	192
-- Install Rented Shore Sys- 12" Slab Soffit x 8 Ft AFF	64.00 sf	4	282	-	-	-	-	4.40 /sf	282
Elevated Slab Rebar and Accessories/Unload & Store	0.21 ton	0	4	2	1	-	-	33.20 /ton	7
Elevated Slab Rebar	0.21 ton		-	197	-	-	-	950.00 /ton	197
-- Install Elevated Slab Rebar	0.21 ton	3	244	-	-	-	-	1,179.80 /ton	244
4500 psi Concrete	2.37 cy		-	308	-	-	-	130.00 /cy	308
4500 psi Concrete (Waste)	0.17 cy		-	22	-	-	-	130.00 /cy	22
Ice Chips	2.37 cy		-	59	-	-	-	25.00 /cy	59
Place Elevated Slab, Pumped	2.37 cy	4	214	-	-	-	-	90.32 /cy	214
Float Finish Elevated Slab	64.00 sf	1	31	-	-	-	-	0.49 /sf	31
Elevated Slab Concrete Pump- 170' Boom (52m)	2.37 cy		-	-	-	77	6	35.00 /cy	83
Burlap Blanket & Water Cure 4 Use	64.00 sf	0	19	2	-	-	-	0.33 /sf	21
Concrete Sealer- Water Based	64.00 sf	0	8	8	-	-	-	0.25 /sf	16
0700.03300.2000 20" Influent Flow Meter Vault Top Slab	**2.37 cy**	**26**	**1,705**	**790**	**1**	**269**	**6**	**1,168.86 /cy**	**2,770**
03300 Concrete, Placement and Finishing		**121**	**7,972**	**4,970**	**448**	**546**	**24**		**13,960**
08300 Specialty Doors									
0700.08300.1010 Influent Flow Meter Slab Hatch									
48x48 Stainless Steel Bilco Floor Access Door, Drainage Frame, Pedestrian Loading, Double Leaf, 300psf, Type JD-2	1.00 EA		-	4,490	-	-	-	4,490.00 /EA	4,490
-- Install 48x48 Stainless Steel Bilco Floor Access Door, Drainage Frame, Pedestrian Loading, Double Leaf, 300psf, Type JD-2	1.00 ea	3	220	-	-	-	-	219.72 /ea	220
0700.08300.1010 Influent Flow Meter Slab Hatch	**1.00 ea**	**3**	**220**	**4,490**				**4,709.72 /ea**	**4,710**
08300 Specialty Doors		**3**	**220**	**4,490**					**4,710**
17420 Instruments									
0700.17420.0000 20" Influent Flow Meter									
20" Magnetic Flowmeter (with Signal Converter)	1.00 ea		-	16,773	-	-	-	16,773.00 /ea	16,773
-- Install 20" Magnetic Flowmeter (with Signal Converter)	1.00 ea	24	1,393	-	-	-	-	1,393.09 /ea	1,393
0700.17420.0000 20" Influent Flow Meter	**1.00 ea**	**24**	**1,393**	**16,773**				**18,166.09 /ea**	**18,166**
17420 Instruments		**24**	**1,393**	**16,773**					**18,166**
0700 YARD PIPING		**836**	**48,337**	**343,187**	**17,156**	**546**	**24**		**409,250**
0800 CO2 TANK/FEEDERS									
02700 Bases, Ballasts, Pavements, and Appurtenances									
0800.02760.1000 Pipe Bollards									
Pipe Bollards, Concrete Filled/Painted, 8' long x 4' deep hole, 8" dia	9.00 ea		-	6,750	-	-	-	750.00 /ea	6,750
--Install Pipe Bollards, Concrete Filled/Painted, 8' long x 4' deep hole, 8" diameter	9.00 ea	36	1,984	-		-	-	220.49 /ea	1,984
0800.02760.1000 Pipe Bollards	**9.00 ea**	**36**	**1,984**	**6,750**				**970.49 /ea**	**8,734**
02700 Bases, Ballasts, Pavements, and Appurtenances		**36**	**1,984**	**6,750**					**8,734**
03300 Concrete, Placement and Finishing									
0800.03300.0000 CO2 Tank/Feeder Slab 12"									
Import Aggregate Base Fill	9.72 cy		-	204	-	170	-	38.50 /cy	374
CRANE - RT - 45T (Max boom Length 105') w/ Operator	1.00 day	8	545	-	739	-	-	1,283.48 /day	1,283
-- Fine Grade Foundation	525.00 sf	4	233	-	-	-	-	0.44 /sf	233
Slab-on-Grade (Edge Form Mat'l), 1-Use	100.00 sf		-	330	-	-	-	3.30 /sf	330
-- Install Slab-on-Grade (Edge Forms), 1-Use	100.00 sf	25	1,692	-	-	-	-	16.93 /sf	1,692
SOG Form Oil & Hardware	100.00 sf		-	50	-	-	-	0.50 /sf	50
SOG Rebar and Accessories/Unload & Store	1.46 ton	0	25	15	9	-	-	33.17 /ton	48
SOG Rebar	1.46 ton		-	1,385	-	-	-	950.00 /ton	1,385
-- Install SOG Rebar	1.46 ton	23	1,720	-	-	-	-	1,179.82 /ton	1,720
4500 psi Concrete	19.44 cy		-	2,528	-	-	-	130.00 /cy	2,528

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
0800.03300.0000 CO2 Tank/Feeder Slab 12"									
4500 psi Concrete (Waste)	1.36 cy		-	177	-	-	-	130.00 /cy	177
Ice Chips	19.44 cy		-	486	-	-	-	25.00 /cy	486
Place SOG, Pumped	19.44 cy	5	245	-	-	-	-	12.60 /cy	245
Float Finish SOG	525.00 sf	4	256	-	-	-	-	0.49 /sf	256
SOG Concrete Pump- 170' Boom (52m)	19.44 cy		-	-	-	194	78	14.00 /cy	272
Water Base Non-Residual Cure	525.00 sf	1	64	32	-	-	-	0.18 /sf	95
0800.03300.0000 CO2 Tank/Feeder Slab 12"	**19.44 cy**	**71**	**4,780**	**5,206**	**747**	**365**	**78**	**574.88 /cy**	**11,176**
03300 Concrete, Placement and Finishing		**71**	**4,780**	**5,206**	**747**	**365**	**78**		**11,176**
09900 Paints and Coatings									
0800.09900.1000 Paint Pipe Bollards									
Pipe Bollard Paint	76.50 sf			55	-	-	-	0.71 /sf	55
--Labor Paint Pipe Bollards	76.50 sf	2	69		-	-	-	0.90 /sf	69
0800.09900.1000 Paint Pipe Bollards	**76.50 sf**	**2**	**69**	**55**				**1.61 /sf**	**123**
09900 Paints and Coatings		**2**	**69**	**55**					**123**
13200 Storage Tanks									
0800.13200.0005 6 Ton Stainless CO2 Storage Tank w/Feed Pumps									
6 Ton Stainless CO2 Storage Tank w/Feed Pumps	1.00 ea	100	6,606	240,000	2,100	-	-	248,705.54 /ea	248,706
0800.13200.0005 6 Ton Stainless CO2 Storage Tank w/Feed Pumps	**1.00 ea**	**100**	**6,606**	**240,000**	**2,100**			**248,705.54 /ea**	**248,706**
13200 Storage Tanks		**100**	**6,606**	**240,000**	**2,100**				**248,706**
0800 CO2 TANK/FEEDERS		**208**	**13,438**	**252,011**	**2,847**	**365**	**78**		**268,739**
0900 LIME/SODA ASH STORAGE									
03300 Concrete, Placement and Finishing									
0900.03300.0000 Lime/Soda Ash Slab on Grade 18"									
Import Aggregate Base Fill	30.09 cy		-	632	-	527	-	38.50 /cy	1,159
Backfill, front end loader, wheel mounted, 5 cy bucket	30.09 cy	0	13	-	11	-	-	0.81 /cy	24
CRANE - RT - 45T (Max boom Length 105') w/ Operator	1.00 day	8	545	-	739	-	-	1,283.48 /day	1,283
-- Fine Grade Foundation	1,625.00 sf	13	721	-	-	-	-	0.44 /sf	721
Slab-on-Grade (Edge Form Mat'l), 1-Use	270.00 sf		-	891	-	-	-	3.30 /sf	891
-- Install Slab-on-Grade (Edge Forms), 1-Use	270.00 sf	68	4,570	-	-	-	-	16.93 /sf	4,570
SOG Form Oil & Hardware	270.00 sf		-	135	-	-	-	0.50 /sf	135
SOG Rebar and Accessories/Unload & Store	9.03 ton	3	156	90	53	-	-	33.17 /ton	299
SOG Rebar	9.03 ton		-	8,577	-	-	-	950.00 /ton	8,577
-- Install SOG Rebar	9.03 ton	144	10,651	-	-	-	-	1,179.82 /ton	10,651
4500 psi Concrete	90.28 cy		-	11,736	-	-	-	130.00 /cy	11,736
4500 psi Concrete (Waste)	6.32 cy		-	821	-	-	-	130.00 /cy	821
Ice Chips	90.28 cy		-	2,257	-	-	-	25.00 /cy	2,257
Place SOG, Pumped	90.28 cy	30	1,631	-	-	-	-	18.06 /cy	1,631
Float Finish SOG	1,625.00 sf	13	791	-	-	-	-	0.49 /sf	791
SOG Concrete Pump- 170' Boom (52m)	90.28 cy		-	-	-	758	361	12.39 /cy	1,119
Water Base Non-Residual Cure	1,625.00 sf	3	198	98	-	-	-	0.18 /sf	295
0900.03300.0000 Lime/Soda Ash Slab on Grade 18"	**90.28 cy**	**282**	**19,275**	**25,237**	**803**	**1,284**	**361**	**520.16 /cy**	**46,960**
0900.03300.2000 Lime/Soda Ash Equipment Tank Slabs									
CRANE - RT - 45T (Max boom Length 105') w/ Operator	1.50 day	12	817	-	1,108	-	-	1,283.48 /day	1,925
Equipment Pad Form Mat'l 8" thick	116.24 sf		-	69	-	-	-	0.59 /sf	69
Equipment Pad Form Oil & Hardware	116.24 sf		-	58	-	-	-	0.50 /sf	58
Epoxy Bonding Agent	806.01 sf		-	403	-	-	-	0.50 /sf	403
-- Install Equipment Pad Forms 8" thick (SF)	116.24 sf	12	787	-	-	-	-	6.77 /sf	787
-- Apply Epoxy Bonding Agent	806.01 sf	24	1,637	-	-	-	-	2.03 /sf	1,637
Equipment Pad Rebar and Accessories/Unload & Store	1.24 ton	0	22	12	7	-	-	33.17 /ton	41
Equipment Pad Rebar	1.24 ton		-	1,182	-	-	-	950.00 /ton	1,182
-- Install Equipment Pad Rebar	1.24 ton	20	1,468	-	-	-	-	1,179.82 /ton	1,468
4500 psi Concrete	19.91 cy		-	2,588	-	-	-	130.00 /cy	2,588
4500 psi Concrete (Waste)	1.39 cy		-	181	-	-	-	130.00 /cy	181
Ice Chips	19.91 cy		-	498	-	-	-	25.00 /cy	498
Place Equipment Pad, Pumped	19.91 cy	11	596	-	-	-	-	29.94 /cy	596
Float Finish Equipment Pad	806.41 sf	6	392	-	-	-	-	0.49 /sf	392
Equipment Pad Concrete Pump- 170' Boom (52m)	19.91 cy		-	-	-	250	80	16.56 /cy	330
Water Base Non-Residual Cure	806.41 sf	2	98	48	-	-	-	0.18 /sf	146
0900.03300.2000 Lime/Soda Ash Equipment Tank Slabs	**19.91 cy**	**87**	**5,817**	**5,040**	**1,115**	**250**	**80**	**617.86 /cy**	**12,302**
03300 Concrete, Placement and Finishing		**370**	**25,092**	**30,277**	**1,918**	**1,534**	**441**		**59,262**
11300 Fluid Waste Treatment & Disposal Equipment									
050.045.11.01001 Lime Storage w/ Feed System									
Lime Storage Packaged System	1.00 ea			1,233,000	-	-	-	1,233,000.00 /ea	1,233,000

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
050.045.11.01001 Lime Storage w/ Feed System									
-- Align, Tack & Erect Steel Tank Outer Walls & Other Shipped Loose Equipment	1.00 ea	600	39,633		7,000	-	-	46,633.00 /ea	46,633
050.045.11.01001 Lime Storage w/ Feed System	1.00 ea	600	39,633	1,233,000	7,000			1,279,633.00 /ea	1,279,633
050.045.11.01002 Soda Ash Storage w/ Feed System									
Soda Storage Packaage System	1.00 ea			781,500	-	-	-	781,500.00 /ea	781,500
-- Align, Tack & Erect Steel Tank Outer Walls & Other Shipped Loose Equipment	1.00 ea	300	19,817		5,000	-	-	24,816.50 /ea	24,817
050.045.11.01002 Soda Ash Storage w/ Feed System	1.00 ea	300	19,817	781,500	5,000			806,316.50 /ea	806,317
11300 Fluid Waste Treatment & Disposal Equipment		900	59,450	2,014,500	12,000				2,085,950
0900 LIME/SODA ASH STORAGE		**1,270**	**84,542**	**2,044,777**	**13,918**	**1,534**	**441**		**2,145,211**
1000 PACKAGED SOFTENING SYSTEM									
03300 Concrete, Placement and Finishing									
1000.03300.0000 Slab on Grade Packaged Softening System 18"									
Import Aggregate Base Fill	118.06 cy		-	2,479	-	2,066	-	38.50 /cy	4,545
Backfill, front end loader, wheel mounted, 5 cy bucket	118.06 cy	5	310	-	265	-	-	4.87 /cy	575
CRANE - RT - 45T (Max boom Length 105') w/ Operator	2.00 day	16	1,089	-	1,478	-	-	1,283.48 /day	2,567
-- Fine Grade Foundation	6,375.00 sf	51	2,828	-	-	-	-	0.44 /sf	2,828
Slab-on-Grade (Edge Form Mat'l), 1-Use	465.00 sf		-	1,535	-	-	-	3.30 /sf	1,535
-- Install Slab-on-Grade (Edge Forms), 1-Use	465.00 sf	116	7,870	-	-	-	-	16.92 /sf	7,870
SOG Form Oil & Hardware	465.00 sf		-	233	-	-	-	0.50 /sf	233
SOG Rebar and Accessories/Unload & Store	35.42 ton	35	2,761	354		-	-	87.97 /ton	3,116
SOG Rebar	35.42 ton		-	33,646	-	-	-	950.00 /ton	33,646
-- Install SOG Rebar	35.42 ton	567	41,786	-	-	-	-	1,179.82 /ton	41,786
4500 psi Concrete	354.17 cy		-	46,042	-	-	-	130.00 /cy	46,042
4500 psi Concrete (Waste)	24.79 cy		-	3,223	-	-	-	130.00 /cy	3,223
Ice Chips	354.17 cy		-	8,854	-	-	-	25.00 /cy	8,854
Place SOG, Pumped	354.17 cy	118	6,397	-	-	-	-	18.06 /cy	6,397
Float Finish SOG	6,375.00 sf	51	3,102	-	-	-	-	0.49 /sf	3,102
SOG Concrete Pump- 170' Boom (52m)	354.17 cy		-	-	-	2,683	1,417	11.58 /cy	4,100
Water Base Non-Residual Cure	6,375.00 sf	13	776	383	-	-	-	0.18 /sf	1,158
1000.03300.0000 Slab on Grade Packaged Softening System 18"	354.17 cy	972	66,920	96,748	1,743	4,749	1,417	484.45 /cy	171,576
1000.03300.1000 Densadeg Equipment Slabs									
CRANE - RT - 45T (Max boom Length 105') w/ Operator	1.00 day	8	545	-	739	-	-	1,283.48 /day	1,283
Equipment Pad Form Mat'l 8" thick	196.00 sf		-	116	-	-	-	0.59 /sf	116
Equipment Pad Form Oil & Hardware	196.00 sf		-	98	-	-	-	0.50 /sf	98
Epoxy Bonding Agent	1,530.00 sf		-	765	-	-	-	0.50 /sf	765
-- Install Equipment Pad Forms 8" thick (SF)	196.00 sf	20	1,327	-	-	-	-	6.77 /sf	1,327
-- Apply Epoxy Bonding Agent	1,530.00 sf	46	3,107	-	-	-	-	2.03 /sf	3,107
Equipment Pad Rebar and Accessories/Unload & Store	2.83 ton	1	49	28	17	-	-	33.17 /ton	94
Equipment Pad Rebar	2.83 ton		-	2,691	-	-	-	950.00 /ton	2,691
-- Install Equipment Pad Rebar	2.83 ton	45	3,342	-	-	-	-	1,179.82 /ton	3,342
4500 psi Concrete	37.78 cy		-	4,911	-	-	-	130.00 /cy	4,911
4500 psi Concrete (Waste)	2.64 cy		-	344	-	-	-	130.00 /cy	344
Ice Chips	37.78 cy		-	944	-	-	-	25.00 /cy	944
Place Equipment Pad, Pumped	37.78 cy	22	1,192	-	-	-	-	31.56 /cy	1,192
Float Finish Equipment Pad	1,530.00 sf	12	745	-	-	-	-	0.49 /sf	745
Equipment Pad Concrete Pump- 170' Boom (52m)	37.78 cy		-	-	-	500	151	17.23 /cy	651
Water Base Non-Residual Cure	1,530.00 sf	3	186	92	-	-	-	0.18 /sf	278
1000.03300.1000 Densadeg Equipment Slabs	37.78 cy	157	10,493	9,989	755	500	151	579.39 /cy	21,889
03300 Concrete, Placement and Finishing		1,129	77,413	106,737	2,498	5,249	1,568		193,465
11225 Clarifier Equipment									
11000.11225.0000 High-Rate Precipitator									
High-Rate Precipitator Units	2.00 ea			1,200,000	-	-	-	600,000.00 /ea	1,200,000
-- Install High-Rate Precipitator Units	2.00 ea	2,400	158,533		14,800	-	-	86,666.48 /ea	173,333
11000.11225.0000 High-Rate Precipitator	2.00 ea	2,400	158,533	1,200,000	14,800			686,666.48 /ea	1,373,333
11225 Clarifier Equipment		2,400	158,533	1,200,000	14,800				1,373,333
1000 PACKAGED SOFTENING SYSTEM		**3,529**	**235,946**	**1,306,737**	**17,298**	**5,249**	**1,568**		**1,566,798**
1100 LIME RESIDUAL TREATMENT									
02200 Site Preparation									
1100.02200.0000 Clear Grub Lime Residual Facility									
Clear & Grub Site - Chip on site and haul	1.00 acre	13	839	-	2,273	-	-	3,112.81 /acre	3,113
1100.02200.0000 Clear Grub Lime Residual Facility	1.00 acre	13	839		2,273			3,112.81 /acre	3,113
1100.02200.1000 Construction Entrance									
ASTM D448 #357 Stone (2.00- No. 4)	15.00 cy		-	168	-		-	11.20 /cy	168

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
1100.02200.1000 Construction Entrance									
Haul import fill, 18 cy dump truck, 35 mph average, cycle 40 miles	15.00 cy	1	83	-	107	-	-	12.70 /cy	191
Filter Fabric	600.00 sf	4	220	450	-	-	-	1.12 /sf	670
1100.02200.1000 Construction Entrance	450.00 sf	5	304	618	107			2.29 /sf	1,029
02200 Site Preparation		19	1,143	618	2,381				4,142
02300 Earthwork									
1100.02230.0000 Construct LRTF - Excavate - Haul Off Site									
Haul excavated material off-site, 18 cy dump truck, 35 mph average, cycle 40 miles	20,740.00 cy	138	8,638	-	11,097	-	-	0.95 /cy	19,735
Excavate and load onto trucks, heavy soil / stiff clay, bulk bank measure, hydraulic excavator, crawler, 5.00 cy bucket	20,740.00 cy	138	9,086	-	31,035	-	-	1.94 /cy	40,122
Labor support during excavation	20,740.00 cy	311	16,848	-	-	-	-	0.81 /cy	16,848
Spread off-site stockpile, dozer (D6)	20,740.00 cy	244	15,361	-	16,831	-	-	1.55 /cy	32,192
1100.02230.0000 Construct LRTF - Excavate - Haul Off Site	20,740.00 cy	832	49,933		58,963			5.25 /cy	108,896
02300 Earthwork		832	49,933		58,963				108,896
02700 Bases, Ballasts, Pavements, and Appurtenances									
1100.02700.0000 Aggregate Paved Roadway									
Stabilized Subgrade w/Compacted Aggregate Surface	1,310.00 sy		-			29,475	-	22.50 /sy	29,475
1100.02700.0000 Aggregate Paved Roadway	1,310.00 sy					29,475		22.50 /sy	29,475
02700 Bases, Ballasts, Pavements, and Appurtenances						29,475			29,475
02800 Site Improvements and Amenities									
1100.02800.0000 Hydroseeding Area									
Hydroseeding - Berms & Slopes	28,000.00 sf			-		5,600		0.20 /sf	5,600
1100.02800.0000 Hydroseeding Area	3,111.11 sy					5,600		1.80 /sy	5,600
02800 Site Improvements and Amenities						5,600			5,600
02820 Fences and Gates									
1100.02820.0000 Site Perimeter Fencing 6'-0"									
Chain Link Fencing, Galvanized Steel, in Concrete, 6-ft high	930.00 lf		-	-	-	24,373	-	26.21 /lf	24,373
Chain Link, Dbl Swing Gate, 20-ft wide x 6-ft high, Manual	2.00 ea		-	-	-	1,480	-	740.00 /ea	1,480
1100.02820.0000 Site Perimeter Fencing 6'-0"	930.00 lf					25,853		27.80 /lf	25,853
02820 Fences and Gates						25,853			25,853
1100 LIME RESIDUAL TREATMENT		**850**	**51,076**	**618**	**61,343**	**60,928**			**173,966**
1200 500 kVa NATURAL GAS GENERATOR									
02700 Bases, Ballasts, Pavements, and Appurtenances									
1200.02760.1000 Pipe Bollards									
Pipe Bollards, Concrete Filled/Painted, 8' long x 4' deep hole, 8" dia	8.00 ea		-	6,000	-	-	-	750.00 /ea	6,000
--Install Pipe Bollards, Concrete Filled/Painted, 8' long x 4' deep hole, 8" diameter	8.00 ea	32	1,764	-		-	-	220.49 /ea	1,764
1200.02760.1000 Pipe Bollards	8.00 ea	32	1,764	6,000				970.49 /ea	7,764
02700 Bases, Ballasts, Pavements, and Appurtenances		32	1,764	6,000					7,764
03300 Concrete, Placement and Finishing									
1200.03300.1000 Generator Pad 18" Thick									
Import Aggregate Base Fill	12.26 cy		-	184	-		-	15.00 /cy	184
CRANE - Hydraulic Truck - 136T (Max boom Length 160') w/ Operator	1.00 day	8	545	-	1,765	-	-	2,309.54 /day	2,310
-- Fine Grade Foundation	662.00 sf	5	294	-	-	-	-	0.44 /sf	294
Equipment Pad Form Mat'l > 8" thick	220.00 sf		-	165	-	-	-	0.75 /sf	165
Equipment Pad Form Oil & Hardware	220.00 sf		-	110	-	-	-	0.50 /sf	110
-- Install Equipment Pad Forms > 8" thick (SF)	220.00 sf	77	5,213	-	-	-	-	23.69 /sf	5,213
Equipment Pad Rebar and Accessories/Unload & Store	4.90 ton	2	85	49	29	-	-	33.17 /ton	163
Equipment Pad Rebar	4.90 ton		-	4,659	-	-	-	950.00 /ton	4,659
-- Install Equipment Pad Rebar	4.90 ton	78	5,786	-	-	-	-	1,179.83 /ton	5,786
4500 psi Concrete	49.04 cy		-	5,394	-	-	-	110.00 /cy	5,394
4500 psi Concrete (Waste)	3.43 cy		-	378	-	-	-	110.00 /cy	378
Ice Chips	49.04 cy		-	245	-	-	-	5.00 /cy	245
Place Equipment Pad, Direct Chute	49.04 cy	74	3,986	-	-	-	-	81.28 /cy	3,986
Float Finish Equipment Pad	662.00 sf	5	322	-	-	-	-	0.49 /sf	322
Burlap Blanket & Water Cure 4 Use	662.00 sf	3	201	16	-	-	-	0.33 /sf	217
-- Fabricate/Place/ Align Anchor Bolts- 2 Bolt Set	8.00 set	3	179	-	-	-	-	22.34 /set	179
1200.03300.1000 Generator Pad 18" Thick	49.04 cy	255	16,610	11,200	1,793			603.65 /cy	29,603
03300 Concrete, Placement and Finishing		255	16,610	11,200	1,793				29,603
09900 Paints and Coatings									
1200.09900.1000 Paint Pipe Bollards									
Pipe Bollard Paint	68.00 sf			48	-	-	-	0.71 /sf	48
--Labor Paint Pipe Bollards	68.00 sf	1	61		-	-	-	0.90 /sf	61

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
1200.09900.1000 Paint Pipe Bollards	8.00 ea	1	61	48				13.69 /ea	109
09900 Paints and Coatings		1	61	48					109
16200 Electrical Power									
1200.16200.1000 500 kVa Natrural Gas Generator									
Standby Generator Set, Low Voltage, Natural Gas, 400KW, 3-Phase, 4-Wire, 480V, 60HZ	1.00 ea		-	170,000	-	-	-	170,000.00 /ea	170,000
-- Install Standby Generator Set, Low Voltage, Natural Gas, 400KW, 3-Phase, 4-Wire, 480V, 60HZ	1.00 ea	160	9,365	-	-	-	-	9,365.28 /ea	9,365
1200.16200.1000 500 kVa Natrural Gas Generator	1.00 ea	160	9,365	170,000				179,365.28 /ea	179,365
16200 Electrical Power		160	9,365	170,000					179,365
1200 500 kVa NATURAL GAS GENERATOR		**448**	**27,800**	**187,248**	**1,793**				**216,842**
1300 BACKWASH STORAGE PUMP STATION									
02300 Earthwork									
1300.02300.0000 Excavate Backfill Backwash Storage Pump Station									
Haul fill from on-site stockpile, 18 cy dump truck, 15 mph average, cycle 1 miles	216.75 cy	5	298	-	383	-	-	3.14 /cy	681
Excavate and load onto trucks, heavy soil / stiff clay, bulk bank measure, hydraulic excavator, crawler, 2.50 cy bucket	1,245.00 cy	11	744	-	1,534	-	-	1.83 /cy	2,278
Labor support during excavation	1,245.00 cy	19	1,011	-	-	-	-	0.81 /cy	1,011
Haul spoils to on-site stockpile, 18 cy dump truck, 15 mph average, cycle 1 miles	1,245.00 cy	12	780	-	1,002	-	-	1.43 /cy	1,783
Spread on-site stockpile, dozer (D6)	1,245.00 cy	15	922	-	1,010	-	-	1.55 /cy	1,932
Load fill from on-site stockpile onto dump truck, backhoe / loader, 3/4 cy bucket	216.75 cy	5	300	-	160	-	-	2.12 /cy	460
Backfill, backhoe / loader, 3/4 cy bucket	216.00 cy	7	453	-	241	-	-	3.22 /cy	695
Labor support during backfill	216.00 cy	7	362	-	-	-	-	1.68 /cy	362
Compact backfill around a building foundation, 8" lifts, walk behind 21" x 24" vibratory plate compactor	216.00 cy	43	2,340	-	123	-	-	11.40 /cy	2,462
TRUCK - Water tanker, 2500 gal (Diesel)	24.00 hr	24	1,511	-	645	-	-	89.82 /hr	2,156
1300.02300.0000 Excavate Backfill Backwash Storage Pump Station	1,245.00 cy	148	8,722		5,098			11.10 /cy	13,820
02300 Earthwork		148	8,722		5,098				13,820
02450 Foundations and Load-Bearing Elements									
1300.02450.0000 Sheetpile Back Wash Pump Sta									
Sheet Pile	2,695.00 sf				-	141,488	-	52.50 /sf	141,488
1300.02450.0000 Sheetpile Back Wash Pump Sta	2,695.00 sf					141,488		52.50 /sf	141,488
02450 Foundations and Load-Bearing Elements						141,488			141,488
03300 Concrete, Placement and Finishing									
1300.03300.0000 Backwash Pmp. Sta. Wet Well Base Slab 18"									
Import Aggregate Base Fill	55.00 cy		-	1,155	-	963	-	38.50 /cy	2,118
Backfill stone, hydraulic excavator, crawler, 2.50 cy bucket	55.00 cy	6	361	-	745	-	-	20.13 /cy	1,107
-- Fine Grade Foundation	1,462.00 sf	12	648	-	-	-	-	0.44 /sf	648
Furnish Mat'l & Place Slab-on-Grade	61.00 cy		-	201	-	38,918	-	641.30 /cy	39,119
1300.03300.0000 Backwash Pmp. Sta. Wet Well Base Slab 18"	55.00 cy	17	1,010	1,356	745	39,881		781.68 /cy	42,992
1300.03300.02000 Backwash Pmp. Sta. Wet Well Roof Deck Slab 12"									
Furnish Mat'l & Install Suspended Slab w/Beams	30.00 cy		-		-	43,260	-	1,442.00 /cy	43,260
Alum Roof Hatch - 3' - 3" x 3' -3"	5.00 ea		-	6,214	-	-	-	1,242.70 /ea	6,214
-- Install Alum Roof Hatch - 3'-0" x 3'-0"	5.00 ea	18	1,204	-	-	-	-	240.73 /ea	1,204
1300.03300.02000 Backwash Pmp. Sta. Wet Well Roof Deck Slab 12"	30.00 cy	18	1,204	6,214		43,260		1,689.24 /cy	50,677
1300.03300.1000 Backwash Pmp. Sta. Wet Well Walls 12"									
Furnish Mat'l & Place Straight Wall, Pumped	49.00 cy			-		63,455	-	1,295.00 /cy	63,455
1300.03300.1000 Backwash Pmp. Sta. Wet Well Walls 12"	49.00 cy					63,455		1,295.00 /cy	63,455
1300.03300.1100 Backwash Pmp. Sta. Wet Well Columns 16"									
Furnish Matl & Place Concrete	6.50 cy		-		-	11,700	-	1,800.00 /cy	11,700
1300.03300.1100 Backwash Pmp. Sta. Wet Well Columns 16"	6.50 cy					11,700		1,800.00 /cy	11,700
1300.03300.115000 Backwash Pmp. Sta. Pipe Gallery Base Slab 12"									
Import Aggregate Base Fill	6.00 cy		-	126	-	105	-	38.50 /cy	231
Backfill, hydraulic excavator, crawler, 2.50 cy bucket	6.00 cy	1	39	-	81	-	-	20.13 /cy	121
-- Fine Grade Foundation	250.00 sf	2	111	-	-	-	-	0.44 /sf	111
Furnish Mat'l & Place Slab-on-Grade	5.00 cy		-		-	3,190	-	638.00 /cy	3,190
1300.03300.115000 Backwash Pmp. Sta. Pipe Gallery Base Slab 12"	6.00 cy	3	150	126	81	3,295		608.77 /cy	3,653
1300.03300.1200 Backwash Pmp. Sta. Pipe Gallery Walls 12"									
Furnish Mat'l & Place Straight Wall, Pumped	11.00 cy			-		14,245	-	1,295.00 /cy	14,245
1300.03300.1200 Backwash Pmp. Sta. Pipe Gallery Walls 12"	11.00 cy					14,245		1,295.00 /cy	14,245
1300.03300.1250 Backwash Pmp. Sta. Pipe Gallery Roof Deck Slab 12"									
Furnish Mat'l & Place Straight Wall, Pumped	4.00 cy			-		5,768	-	1,442.00 /cy	5,768
Alum Roof Hatch - 3' - 3" x 3' -3"	2.00 ea		-	2,485	-	-	-	1,242.70 /ea	2,485
-- Install Alum Roof Hatch - 3'-0" x 3'-0"	2.00 ea	7	481	-	-	-	-	240.74 /ea	481
1300.03300.1250 Backwash Pmp. Sta. Pipe Gallery Roof Deck Slab 12"	4.00 cy	7	481	2,485		5,768		2,183.72 /cy	8,735

Spreadsheet Level	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
03300 Concrete, Placement and Finishing		**45**	**2,845**	**10,181**	**827**	**181,604**			**195,457**
11200 Water Supply and Treatment Equipment									
1300.11000.1000 Backwash Pumps									
Freight & Shipping Insurance	1.00 ea				-	2,500	-	2,500.00 /ea	2,500
Start-up Service, Training, & O&M Manuals	1.00 days		-	-	-	1,200	-	1,200.00 /days	1,200
Submersible Centrifugal Pumps 15 HP w/ AFDs	2.00 ea			45,000	-	-	-	22,500.00 /ea	45,000
Epoxy Lined Base Elbow w/ Lock Connection 24"	2.00 ea			11,200	-	-	-	5,600.00 /ea	11,200
Hook Safety Assembly	2.00 ea			93	-	-	-	46.50 /ea	93
Hardware Kit	2.00 ea			130	-	-	-	65.00 /ea	130
Chain 3/8" SST	45.00 lf			2,529	-	-	-	56.20 /lf	2,529
Klt Chain Fitting 316 SST	2.00 ea			112	-	-	-	56.00 /ea	112
Misc Sensors & Power Cable	2.00 ea			7,000	-	-	-	3,500.00 /ea	7,000
Guide Rail SST	80.00 lf			2,032	-	-	-	25.40 /lf	2,032
Mounting Brackets for Guiderail	2.00 ea			156	-	-	-	78.00 /ea	156
Pump Control Cabinet	2.00 ea			5,400	-	-	-	2,700.00 /ea	5,400
Spare Parts	2.00 ea			5,000	-	-	-	2,500.00 /ea	5,000
---Align & Set Mounting Base Elbow	2.00 ea	36	2,402		-	-	-	1,201.00 /ea	2,402
---Align & Set Guide Rail System	2.00 ea	36	2,402		-	-	-	1,201.00 /ea	2,402
---Align & Set Upper Support Systems	2.00 ea	18	1,201		-	-	-	600.50 /ea	1,201
---Align & Set Pump	2.00 ea	55	3,603		-	-	-	1,801.50 /ea	3,603
---Align & Set Control Cabinet	2.00 ea	18	1,201		-	-	-	600.50 /ea	1,201
---Start-up & Testing	1.00 ea	36	2,402		-	-	-	2,402.00 /ea	2,402
---Drill & Set Anchor Bolts	8.00 ea	2	120		-	-	-	15.01 /ea	120
Adhesive Anchor Rod w/Epoxy 316 SS - 1/2" x 12"	8.00 ea			132	-	-	-	16.48 /ea	132
-- Storage & Handling of Equipment	1.00 day	8	433	-	556	-	-	989.61 /day	990
-- Hoisting Equipment - RT Crane 89 MT	1.00 day	8	545	-	1,260	-	-	1,804.60 /day	1,805
1300.11000.1000 Backwash Pumps	**2.00 ea**	**218**	**14,309**	**78,784**	**1,816**	**3,700**		**49,304.57 /ea**	**98,609**
11200 Water Supply and Treatment Equipment		**218**	**14,309**	**78,784**	**1,816**	**3,700**			**98,609**
15200 Process Piping									
1300.15000.100 6"-10" DIP Backwash Discharge Piping									
6"- 10" DI Pipe, CL53, Mortar-Lined,	1.00 ls		-	3,000	-	-	-	3,000.00 /ls	3,000
-- Install 6"-10" DI Pipe, CL53,	1.00 ls	22	1,908	-	-	-	-	1,907.71 /ls	1,908
1300.15000.100 6"-10" DIP Backwash Discharge Piping	**1.00 ls**	**22**	**1,908**	**3,000**				**4,907.71 /ls**	**4,908**
15200 Process Piping		**22**	**1,908**	**3,000**					**4,908**
15250 Process Valves									
1300.15000.100 6"-10" DIP Backwash Discharge Piping									
Butterfly Valve, CI Body, 150#, Flanged, Lever/Handwheel, 6"	2.00 ea		-	834	-	-	-	417.00 /ea	834
-- Install Butterfly Valve, CI Body, 150#, Flanged, Lever/Handwheel, 6"	2.00 ea	13	1,098	-	-	-	-	548.90 /ea	1,098
Cushioned Check Valve, CI Body, Flanged, 6"	2.00 ea		-	2,822	-	-	-	1,411.00 /ea	2,822
-- Install Cushioned Check Valve, CI Body, Flanged, 6"	2.00 ea	8	682	-	-	-	-	340.79 /ea	682
1300.15000.100 6"-10" DIP Backwash Discharge Piping	**1.00 ls**	**21**	**1,779**	**3,656**				**5,435.37 /ls**	**5,435**
15250 Process Valves		**21**	**1,779**	**3,656**					**5,435**
1300 BACKWASH STORAGE PUMP STATION		**453**	**29,563**	**95,621**	**7,741**	**326,791**			**459,716**

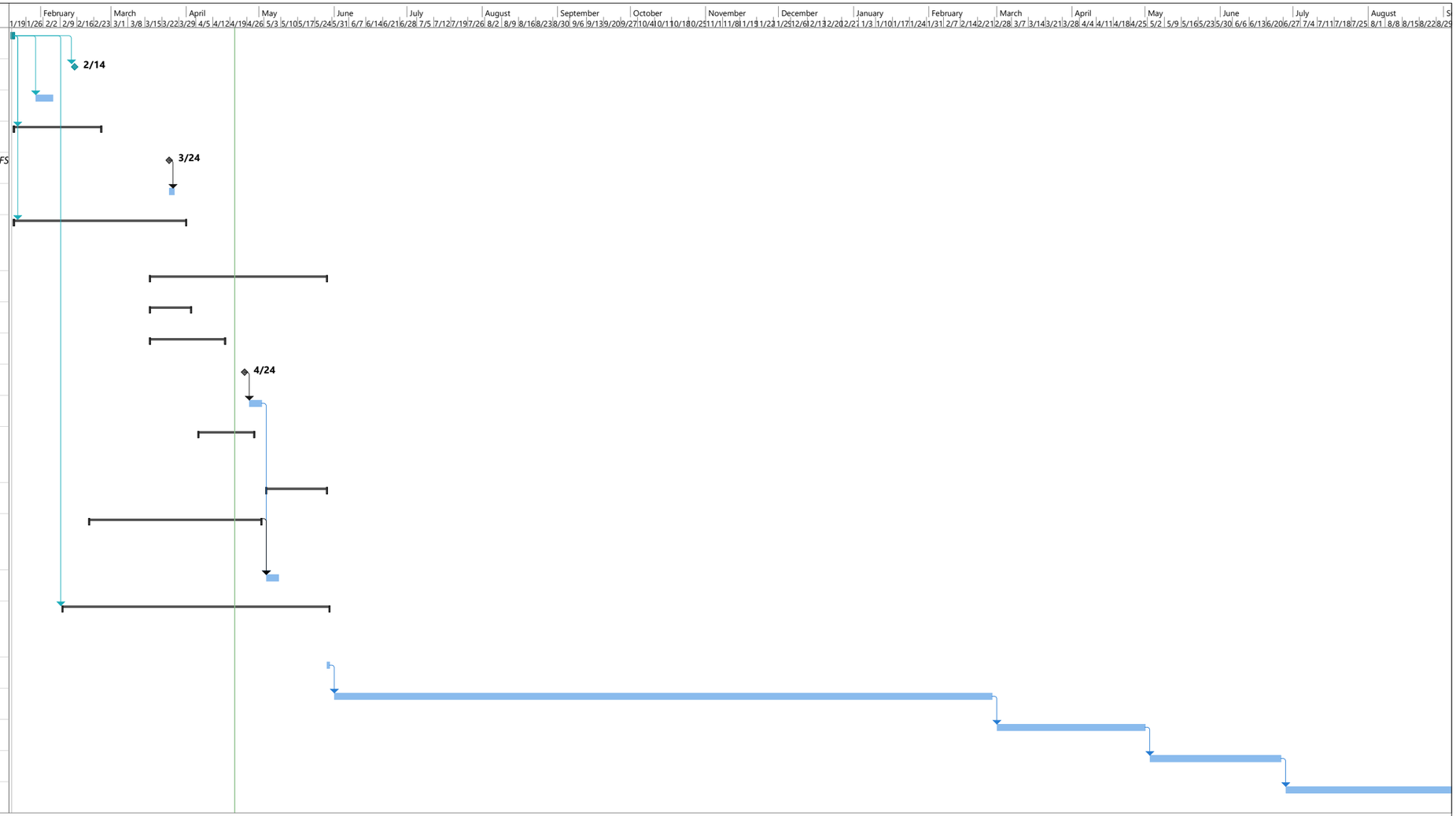
Estimate Totals

Description	Amount	Totals	Hours	Rate		Percent of Total
Labor	1,816,155		27,996			12.24%
Material	7,263,099					48.97%
Subcontract	1,317,059					8.88%
Equipment	227,018		8,437			1.53%
Other	6,194					0.04%
TOTAL DIRECT COST	**10,629,525**	***10,629,525***				**71.66**
SUBCONTRACTOR MARK-UP'S						
Subcontractor-Gen. Conditions	118,130			6.000	%	0.80%
Subcontractor-Overhead	78,754			4.000	%	0.53%
Subcontractor-Fee	78,754			4.000	%	0.53%
Subcontractor-Bond/Insurance	24,611			1.250	%	0.17%
GRAND TOTAL DIRECT COST	**300,249**	***10,929,774***				**2.02**
RISK ASSESSMENT MARK-UP's						
Construction Contingency	1,639,466			15.000	%	11.05%
Deduct Equipment Contingency	(246,000)					-1.66%
TOTAL INCLUDING RISK	**1,393,466**	***12,323,240***				**9.39**
GENERAL REQUIREMENTS						
General Conditions Management	677,778			5.500	%	4.57%
General Conditions Temp Fac	123,232			1.000	%	0.83%
General Conditions Equipment	61,616			0.500	%	0.42%
General Conditions Start-up	92,424			0.750	%	0.62%
General Conditions Permits	61,616			0.500	%	0.42%
TOTAL INCLUDING GC'S	**1,016,666**	***13,339,906***				**6.85**
CONTRACTOR FEE						
General & Administrative Costs	426,543			3.198	%	2.88%
Profit (Fee)	883,311			5.955	%	5.96%
TOTAL INCLUDING FEE	**1,309,854**	***14,649,760***				**8.83**
INSURANCES & BOND						
Builders All Risk Insurance	46,879			0.320	%	0.32%
General Liability Insurance	29,666			0.200	%	0.20%
Payment & Performance Bond	106,798			0.720	%	0.72%
TOTAL CONSTRUCTION COST	**183,343**	***14,833,103***				**1.24**
Total		**14,833,103**				

Appendix B.

Project Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
1	Notice to Proceed	1 day	Mon 1/20/20	Mon 1/20/20	
2	*Project Initiation Meeting*	*1 day*	*Fri 2/14/20*	*Fri 2/14/20*	*1*
3	Data Request	5 days	Thu 1/30/20	Wed 2/5/20	1FS+7 days
4	**Water Supply Evaluation**	**26 days**	**Tue 1/21/20**	**Tue 2/25/20**	**1**
15	*Water Supply Memo Review Meeting*	*1 day*	*Tue 3/24/20*	*Tue 3/24/20*	*14FS+5 days,26FS*
16	Finalize Water Supply Memo	2 days	Wed 3/25/20	Thu 3/26/20	15
17	**Water Treatment Technology Evaluation**	**51 days**	**Tue 1/21/20**	**Tue 3/31/20**	**1**
29	**Conceptual Design**	**53 days**	**Tue 3/17/20**	**Thu 5/28/20**	
30	Geotechnical Investigation	13 days	Tue 3/17/20	Thu 4/2/20	
33	Facility Plan	23 days	Tue 3/17/20	Thu 4/16/20	
40	*Facility Plan Review Meeting*	*1 day*	*Fri 4/24/20*	*Fri 4/24/20*	*39FS+5 days*
41	Finalize Facility Plan	5 days	Mon 4/27/20	Fri 5/1/20	40
42	Develop Opinion of Probable Construction Cost	17 days	Mon 4/6/20	Tue 4/28/20	
48	Regulatory Agency Review	19 days	Mon 5/4/20	Thu 5/28/20	
53	**Evaluate Wholesale Purchase of Softened Water**	**51 days**	**Fri 2/21/20**	**Fri 5/1/20**	
65	**Update City Rate Model**	**5 days**	**Mon 5/4/20**	**Fri 5/8/20**	**53,41**
66	**Financial Funding Evaluation Memo**	**80 days**	**Mon 2/10/20**	**Fri 5/29/20**	**1**
74	**Preliminary Design Complete**	1 day	Fri 5/29/20	Fri 5/29/20	73FS-1 day
75	**Detailed Design**	195 day	Mon 6/1/20	Fri 2/26/21	74
76	**Regulatory Review**	45 days	Mon 3/1/21	Fri 4/30/21	75
77	**Advertisement and Award**	40 days	Mon 5/3/21	Fri 6/25/21	76
78	**Construction**	520 day	Mon 6/28/21	Fri 6/23/23	77



Project: sch_Bonner Springs WT
Date: Tue 4/21/20

Task | Milestone | Project Summary | Inactive Milestone | Manual Task | Manual Summary Rollup | Start-only | External Tasks | Deadline | Manual Progress
Split | Summary | Inactive Task | Inactive Summary | Duration-only | Manual Summary | Finish-only | External Milestone | Progress

Appendix C.

Code Classification Table

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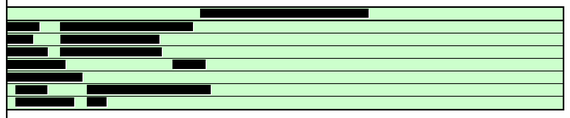

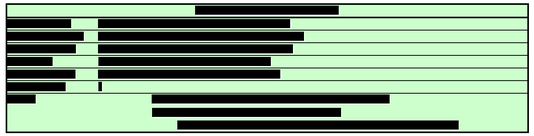

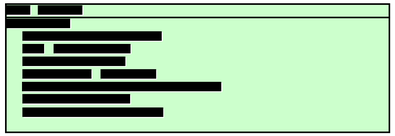

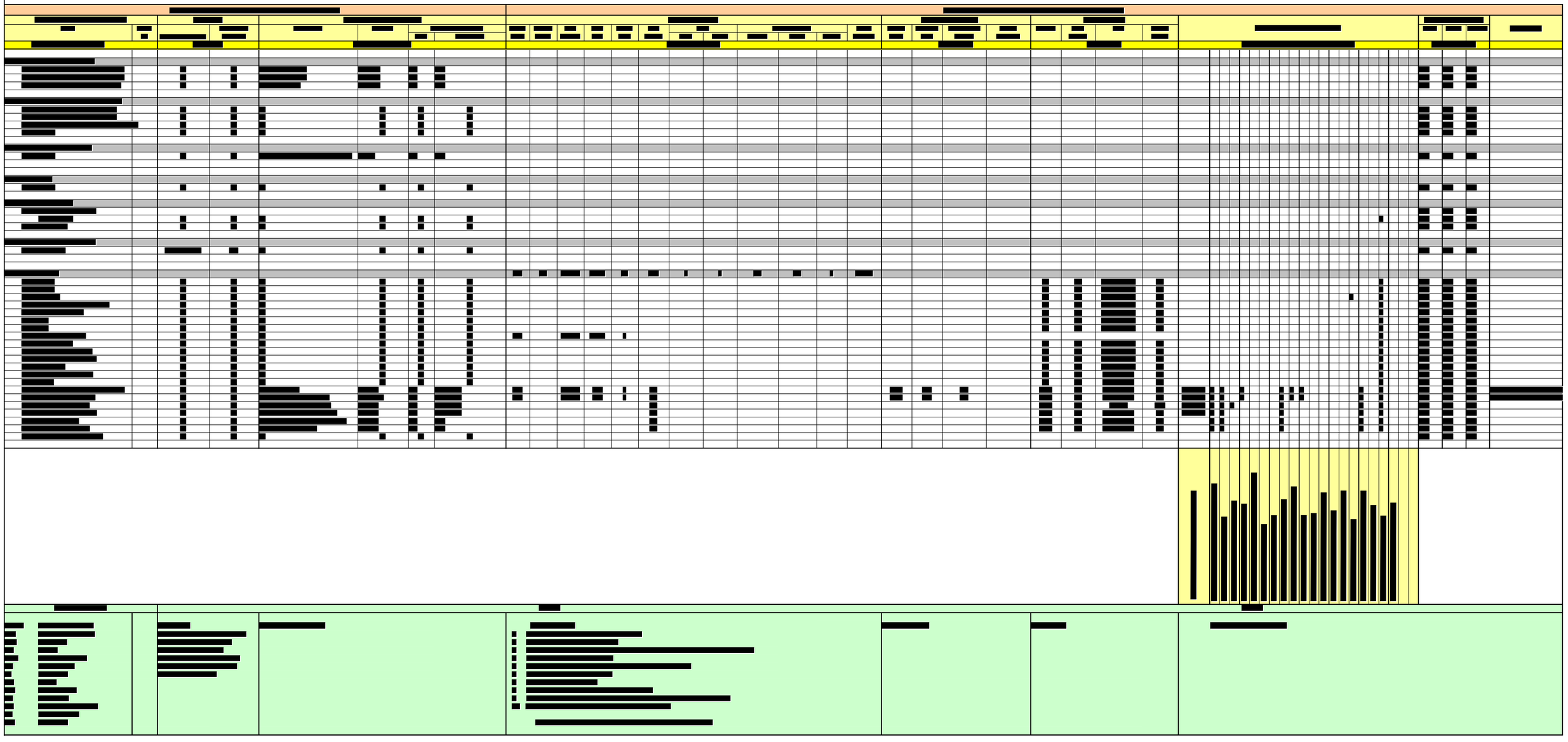

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Appendix D.

Preliminary Geotechnical Report

PRELIMINARY GEOTECHNICAL EXPLORATION
WATER SUPPLY AND TREATMENT PLANT STUDY
12401 KAW DRIVE
BONNER SPRINGS, KANSAS

Prepared for:

BLACK & VEATCH CORPORATION
KANSAS CITY, MISSOURI

Prepared by:

GEOTECHNOLOGY, INC.
OVERLAND PARK, KANSAS

Date:

APRIL 29, 2020

Geotechnology Project No.:

J035801.01

SAFETY
QUALITY
INTEGRITY
PARTNERSHIP
OPPORTUNITY
RESPONSIVENESS

April 29, 2020

Mr. Jim Winger, P.E.
Black & Veatch Corporation
8400 Ward Parkway
Kansas City, Missouri 64114

Re: Preliminary Geotechnical Exploration
Water Supply and Treatment Plant Study
12401 Kaw Drive
Bonner Springs, Kansas
Geotechnology Project No. J035801.01

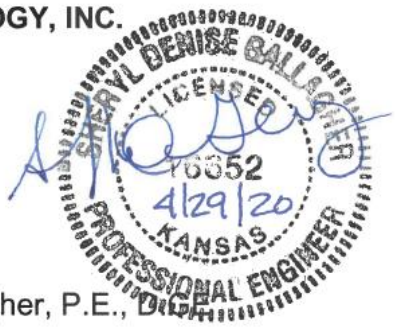
Dear Mr. Winger:

Presented in this report are the results of a preliminary geotechnical exploration conducted for the referenced project. This report includes our project understanding, observed site conditions, preliminary conclusions and/or recommendations for the project, and support data as given in the Table of Contents.

We appreciate the opportunity to provide geotechnical services for this project. If you have questions regarding this report, or if we may be of any additional service to you, please contact the undersigned.

Respectfully submitted,

GEOTECHNOLOGY, INC.



Sheryl D. Gallagher, P.E., D.GE
Principal Engineer

SDG/MHM:sdg/ljd

Copies: electronic pdf and 3 bound

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APPENDICES

PRELIMINARY GEOTECHNICAL EXPLORATION
WATER SUPPLY AND TREATMENT PLANT STUDY
12401 KAW DRIVE
BONNER SPRINGS, KANSAS

April 29, 2020 | Geotechnology Project No. J035801.01

1.0 INTRODUCTION

The services documented in this report were performed in accordance with Black & Veatch Corporation Geotechnical Services Contract No. 404408.70.1110 dated March 24, 2020. The purpose of our services was to explore subsurface conditions, provide information to characterize the site, and provide general geotechnical considerations for preliminary planning. Briefly, our services consisted of drilling one boring, laboratory testing, engineering evaluation, and preparation of this report.

2.0 PROJECT INFORMATION

The project includes the construction of a greenfield high rate precipitative softening plant near the existing water treatment plant. The existing plant will not be reused or incorporated into the new facility. The new plant is expected to house chemicals, storage silos and tanks, a treated water reservoir and office space. The lowest slab is expected near El 768; however, the pump station wet well is expected to be at a lower elevation. Grading across the site is expected to include cuts and fills of less than 2 feet.

3.0 SITE CONDITIONS

The project site is grass covered, relatively flat and within an alluvial terrace of the Kansas River. A well log from the nearby pumping field indicates shale bedrock is present near a depth of 80 feet. The site location and regional topography of the area are shown on Figure 1 given in Appendix B.

4.0 FIELD EXPLORATION

The field exploration consisted of drilling one boring (designated as Boring B-1) at approximately the location shown on Figure 2 given in Appendix B. The elevation at the boring location, as shown on the boring log given in Appendix C, was interpolated from Google Earth. A professional surveyor should determine the boring location if accurate data is required.

The boring was drilled using a track-mounted CME-55 rotary drill rig equipped with 3 3/4-inch inside diameter hollow-stem augers to a depth of 45 feet. Below a depth of 45 feet, rotary wash methods were utilized. The boring was terminated at sampler refusal at a depth of approximately 84 feet. Sampling of the overburden soils was accomplished at the depths indicated on the boring log with 2-inch outside-diameter (O.D.) split-spoons and 3-inch inside diameter (I.D.) Shelby

tubes, in general accordance with the procedures outlined by ASTM D1586. Standard Penetration Tests (SPTs) using a split-spoon sampler were performed to obtain the N-value[1] of the sampled material.

An engineer from Geotechnology prepared a field log of the material encountered. The boring log represents conditions observed at the time of exploration and the log has been edited by a professional engineer to incorporate results of the laboratory tests.

Unless noted on the boring log, the lines designating the changes between various strata represent approximate boundaries. The transition between materials could be gradual or could occur between recovered samples. The stratification given on the boring log, or described herein, is for use by Geotechnology in its analyses and should not be used as the basis of design or construction cost estimates without realizing that there can be variation from that shown or described.

The boring log and related information depict subsurface conditions only at the specific location and time where sampling was conducted. The passage of time could result in changes in conditions, interpreted to exist, at the location where sampling was conducted.

5.0 LABORATORY TESTING

Laboratory testing was performed on soil samples to estimate engineering and index properties. Moisture contents and Atterberg limits tests were performed on selected soil samples. Liquid limits ranged from 59 to 91 percent and plastic limits ranged from 18 to 35 percent for the tested samples. Dry unit weight determinations and unconfined compression tests were performed on Shelby tube samples. Dry unit weights ranged from 88 to 97 pounds per cubic foot and unconfined compressive strengths ranged from 0.78 to 1.34 tons per square foot. Laboratory test results are presented on the boring log.

6.0 SUBSURFACE CONDITIONS

6.1 Stratigraphy

One foot of fat clay fill forms the surface cover at Boring B-1. Medium stiff to stiff fat clay underlies the fill and extends to a depth of approximately 42 feet. Medium dense and dense sand extends to a depth of approximately 84 feet where sampler refusal occurred. Sampler refusal might represent a boulder, limestone ledge or competent rock. Since rock coring was not performed the character of the refusal material could not be determined.

[1] The Standard Penetration Test value, or N-value, is defined as the number of blows required to drive the split-spoon sampler 12 inches with a 140-pound hammer falling 30 inches. Since the split-spoon sampler is driven 18 inches or until refusal, the blows for the first 6 inches are for seating the sampler, and the number of blows for the final 12 inches is the N-value.

6.2 Groundwater Conditions

Groundwater was not observed in the boring during drilling prior to a depth of 45 feet where rotary wash methods were utilized. Rotary wash methods introduce drilling fluid into the borehole which masks the presences of groundwater. Consequently, the lack of an indicated groundwater level might not represent present or future levels. In addition, soil moisture contents range from 32 to 39 percent below a depth of approximately 10 feet. Such moisture contents are indicative of groundwater. Groundwater levels can vary over time due to the effects of seasonal variation in precipitation and recharge, the level of the Kansas River, or other factors not evident at the time of exploration. Excavations that remain open might collect water.

7.0 PRELIMINARY DESIGN CONSIDERATIONS

Considerations for geotechnical aspects of site development are presented herein to assist the client with planning and preliminary design of the project. Additional evaluation and exploration for the structure will be required to provide geotechnical recommendations for final design. Subsurface features that will influence the geotechnical approach to the proposed development include the presence of existing fill and fat clay, and the suitability of the soils for supporting lightly loaded structures. A discussion of these features and potential foundation alternatives are presented in the following section.

7.1 Features Impacting the Project

Fill. Fill was encountered to a depth of approximately 12 inches at the boring location. Fill might extend to greater depths in unexplored locations. The presence of fill complicates the project. If fill placement observation and testing records are not available, the fill should be considered uncontrolled and potentially compressible. The risks associated with supporting foundations and floor slabs on uncontrolled fill include total and differential settlement in excess of tolerable limits. Differential settlement can lead to cosmetic and structural distress, including substantial cracking in walls and floor slabs. In the absence of placement records, fill within the building area should be removed and replaced with engineered fill.

Foundations. Relatively lightly loaded structures, i.e. structures with column loads of less than 150 to 200 kips, may be supported on soil-bearing footings. More heavily loaded structures could require deep foundations. Potential deep foundation types include steel piles driven to bedrock, pipe piles and soil-bearing auger-cast piles. Drilled piers might not be economically feasible due to the apparent depth to bedrock, combined with the anticipated shallow depth to water and sand.

In lieu of deep foundations, specialty ground improvement techniques can be used to improve the density and strength of the overburden to reduce the potential settlement of shallow-bearing foundations. These techniques include deep soil mixing (DSM), grouting, vibro-compaction and compacted rock columns. Design of a ground improvement system is performed by a specialty contractor and not discussed in this report.

Fat Clays. Fat clay was encountered at the boring. Fat clays are potentially expansive. Lightly loaded structural features such as floor slabs and pavements can undergo heaving and distress unless these soils are mitigated. Removing and replacing the potentially expansive soil with lean clays or chemically treating the soil can reduce the swell potential, and must be considered during the planning for the development.

7.2 Foundations

Strip and Spread Footings. Site soils are generally suitable for construction of spread and strip footings. Lightly loaded structures may be supported on strip and spread footings, assuming that total and differential settlements on the order of 1 inch and 1/2- to 3/4-inches, respectively, are acceptable.

For preliminary planning purposes, for column loads less than 150 to 200 kips, foundation bearing pressures in the range of 1,500 to 2,500 pounds per square foot (psf) may be assumed for footings bearing on firm, natural soil or newly compacted fill. Exterior footings and footings in unheated areas bearing on native soil or engineered fill should be embedded 36 inches below the lowest adjacent exterior grade to provide protection from seasonal moisture variations and frost penetration.

Driven Piles. Steel H-piles may be designed for an allowable compressive stress of 9 kips per square inch (ksi). For example, an HP 12x53 pile designed for an allowable compressive stress of 9 ksi will support an allowable compressive load of 140 kips. The allowable stress is based on the pile being driven to practical refusal on competent rock. Steel piles may be designed for higher pile capacities (up to 15 ksi) provided such capacities are verified through static or dynamic testing (e.g., pile driving analyzer).

Concrete-filled pipe piles end-bearing in the medium dense sand may also be considered. In general, pipe piles have diameters of 12 to 20 inches and allowable axial capacities of 50 to 100 kips. Uplift capacities could range from 20 to 50 kips depending on the diameter and length of pile.

Driven steel piles should not be spaced closer than three (3) pile widths center-to-center. Settlement of driven pile foundations is expected to be less than 1 inch.

Auger-Cast Piles. Auger-cast piles are installed by rotating a continuous flight hollow-shaft into the ground and pumping grout to fill the hole as the auger is withdrawn. A head of grout combined with a continuous rate of auger withdrawal are maintained to resist hydrostatic pressure and necking of the pile. The resulting column of concrete serves as the pile. In general, auger-cast piles have diameters of 16 to 24 inches and lengths of 50 to 70 feet. Typically, auger-cast piles have axial capacities of 100 to 150 kips. The grout should have a 28-day compressive strength of 4,000 psi or greater. As a minimum, the piles should have a reinforced cage in the upper 15 feet. Center-to-center spacing of the piles in a group should not be less than three (3) times the diameter of the pile. Settlement of auger-cast pile foundations is expected to be less than 1 inch.

7.3 Slabs-on-Grade

Floor slabs can be supported on-grade. However, fat clay occurring at floor slab subgrade should be remediated as discussed herein. In general, floor slabs should be isolated from bearing elements to allow for differential movements that normally occur between the floor slab, columns, and foundation walls. Floor slabs should be underlain by a 24-inch thick zone of low volume change (LVC) material. LVC materials may consist of lean clays, well-graded crushed limestone and chemically treated clay. A plastic vapor barrier can be placed below floors in interior finished areas to reduce the potential for moisture permeation through the slab, and to reduce the potential for mold growth within the building.

7.4 Dewatering

Surface drainage should be controlled to prevent flow of surface water into excavations. Seepage forces might increase risk of instability of excavations. It is anticipated that groundwater into shallow excavations can be controlled by use of sumps and pumps. However, deep excavations that extend below the river level might require dewatering wells. Installation of a piezometer should be considered where deep excavations are planned.

7.5 Below-Grade Walls

Walls with fixed heads and below-grade walls should be designed for at-rest lateral earth pressures; i.e. 55 to 70 pounds per cubic foot (pcf), depending on the wall backfill type (well-graded crushed limestone and lean clay, respectively). Walls permitted to rotate (tilt forward) may be designed for active lateral earth pressures; i.e. 35 to 45 pcf, depending on the soil type (well-graded crushed limestone and lean clay, respectively). Passive resistance values of 320 to 560 pcf, depending on the soil type (well-graded crushed limestone and lean clay, respectively), may be used and should be ignored in the upper 36 inches below proposed grade due to seasonal variations in moisture and frost penetration. In giving these values, it is assumed that the wall backfill will be properly compacted and that hydrostatic pressures will not develop behind the walls. Undrained walls may be subjected to hydrostatic pressure from perched water, pipe leakage or surface water infiltration. Therefore, a drainage system should be constructed around the perimeter of a below-grade structure where possible. Walls should be designed to resist hydrostatic pressures where drainage is not feasible.

7.6 Pavement Considerations

Standard asphaltic concrete pavement design for a given service life requires estimates of daily traffic volumes and axle weights, and a soil evaluation by California Bearing Ratio (CBR) tests or other methods. Typical CBR values for the Kansas City metropolitan area range from 1 to 3. Thinner pavement sections than those determined from formal design methods are frequently used and often perform adequately. The durability of these pavement sections depends on good maintenance and on sufficient subgrade and surface drainage. An overlay is generally required sooner with these reduced thickness sections than would be required for a designed section. Where heavy channelized wheel loads are concentrated, particularly at street entrances and in front of trash dumpsters and loading docks, concrete pavement should be used.

Pavement service life can decrease substantially if the pavement is constructed on a poor subgrade, if it has poor surface or subsurface drainage, and/or if the pavement is not maintained. Periodic maintenance, such as filling cracks and sealing, is required for a pavement section to achieve its design life.

7.7 Seismic Site Class

Per the general procedures of the 2012 edition of the International Building Code (IBC), the soil profile at the project site will be based on the top 100 feet of material. The seismic soil profile of the project site is Class D (Stiff Soil). This designation is based on the results of the boring and our local knowledge of the geologic conditions in the area.

7.8 Corrosion Considerations

Corrosion testing was not included during this phase of the project. The Soil Survey for Leavenworth and Wyandotte Counties, Kansas map this soil as slightly acidic to neutral. Further testing should be implemented to determine the potential corrosivity to steel and concrete.

7.9 Site Earthwork and Grading

Site Preparation. At a minimum, site preparation prior to placement of new fills should consist of clearing and grubbing grass, and stripping of existing fill or other deleterious material. Upon completion of site stripping, the exposed soil subgrade should be proofrolled. Subgrade areas that exhibit excessive deflection and rutting during proofrolling should be overexcavated and replaced with compacted fill or reworked and compacted.

Remediation of Fat Clay. Fat clay was encountered in the boring. Fat clays have the potential for volume change due to fluctuation in moisture content throughout the life of the structure. Swelling and consequent heaving of floors can occur when a fat clay subgrade absorbs moisture. Alternatively, shrinkage and consequent loss of subgrade support can occur when a fat clay subgrade desiccates. Fat clay within 24 inches of floor slab subgrade should be remediated. Potential remediation measures include excavation and replacement with LVC material or stabilization with cement, lime, fly ash, cement kiln dust (CKD) or lime kiln dust (LKD). Remediation of fat clay occurring at pavement subgrades could also be performed as a measure to improve pavement performance.

Suitable Fill Materials. Materials generated from on-site excavations are expected to include topsoil and fat clay. The fat clay may be reused for structural fill provided it is placed sufficiently deep below floor slab and pavement subgrades; i.e. 24 inches and 9 inches, respectively. Fat clay may be reused at shallower depths, provided the fat clay is stabilized. Topsoil should be used in landscape areas or hauled off the site and properly disposed. Off-site soils recommended for fill include lean clay (liquid limit less than 45) and well-graded crushed limestone with a 2-inch maximum particle size. Permeable material, i.e. clean rock and sand, should not be used for trench backfill. Permeable backfill can collect water and promote subgrade softening, or in the

presence of fat clay, promote subgrade heaving, or lead to the migration of fines and loss of subgrade support.

Fill and Backfill Placement. Successful performance of the planned structures will require that new fills be carefully placed and compacted. In general, new fills should be placed in thin lifts (6- to 8-inches typical) and compacted with multiple passes of compaction equipment. Cohesive fill should be compacted using kneading equipment (e.g. sheepsfoot roller), and granular fill should be compacted using vibratory equipment (e.g. vibratory roller). Compaction of fill using tracking methods is typically not successful and problematic. Each lift of fill should be visually observed and tested to evaluate placement conditions. Specific compaction criteria will be developed as part of final geotechnical design.

Temporary Slopes. We anticipate that, in most cases, open-cut excavations can be used to construct the proposed structures. Excavation slopes should be consistent with OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations. Excavation depths of more than 20 feet are anticipated; slopes of such excavations should be designed by a professional engineer.

8.0 RECOMMENDED ADDITIONAL SERVICES

The preliminary engineering evaluation given in this report is based on interpretation of limited exploration data and Geotechnology's experience. The client must recognize that variations may occur from conditions observed in the boring. This report is a preliminary subsurface exploration and should not be used for final design. Geotechnology will not be responsible for improper use of the engineering comments herein or failure by others to recognize conditions that may be detrimental to the successful design of the project. Additional geotechnical evaluation and borings to confirm consistency of the soil profile should be performed.

9.0 LIMITATIONS

This preliminary report has been prepared on behalf of, and for the exclusive use of the client for specific application to the named project as described herein. If this report is provided to other parties it should be provided in its entirety with all supplementary information. In addition, the client should make it clear that the information is provided for factual data only, and not as a warranty of subsurface conditions presented in this report.

Geotechnology has attempted to conduct the services reported herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions. The preliminary recommendations and conclusions contained in this report are professional opinions. The report is not a bidding document and should not be used for that purpose.

The analyses, conclusions, and preliminary recommendations contained in this report are based on the data obtained from the subsurface exploration. The field exploration methods used indicate subsurface conditions only at the specific locations where samples were obtained, only at the time they were obtained, and only to the depths penetrated. Consequently, subsurface

conditions may vary gradually, abruptly, and/or nonlinearly between sample locations and/or intervals.

The conclusions or preliminary recommendations presented in this report should not be used without Geotechnology's review and assessment if the nature, design, or location of the facilities is changed, if there is a substantial lapse in time between the submittal of this report and the start of work at the site, or if there is a substantial interruption or delay during work at the site. If changes are contemplated or delays occur, Geotechnology must be allowed to review them to assess their impact on the findings, conclusions, and/or design recommendations given in this report.-Geotechnology will not be responsible for any claims, damages, or liability associated with any other party's interpretations of the subsurface data or with reuse of the subsurface data or engineering analyses in this report.

The preliminary recommendations included in this report have been based in part on assumptions about variations in site stratigraphy that may be evaluated further during earthwork and foundation construction. Geotechnology should be retained to perform construction observation and continue its geotechnical engineering service using observational methods. Geotechnology cannot assume liability for the adequacy of its recommendations when they are used in the field without Geotechnology being retained to observe construction.

A copy of "Important Information about This Geotechnical-Engineering Report" that is published by the Geotechnical Business Council (GBC) of the Geoprofessional Business Association (GBA) is included in Appendix A for your review. The publication discusses some other limitations, as well as ways to manage risk associated with subsurface conditions.

APPENDIX A

Important Information about This Geotechnical-Engineering Report

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly

problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

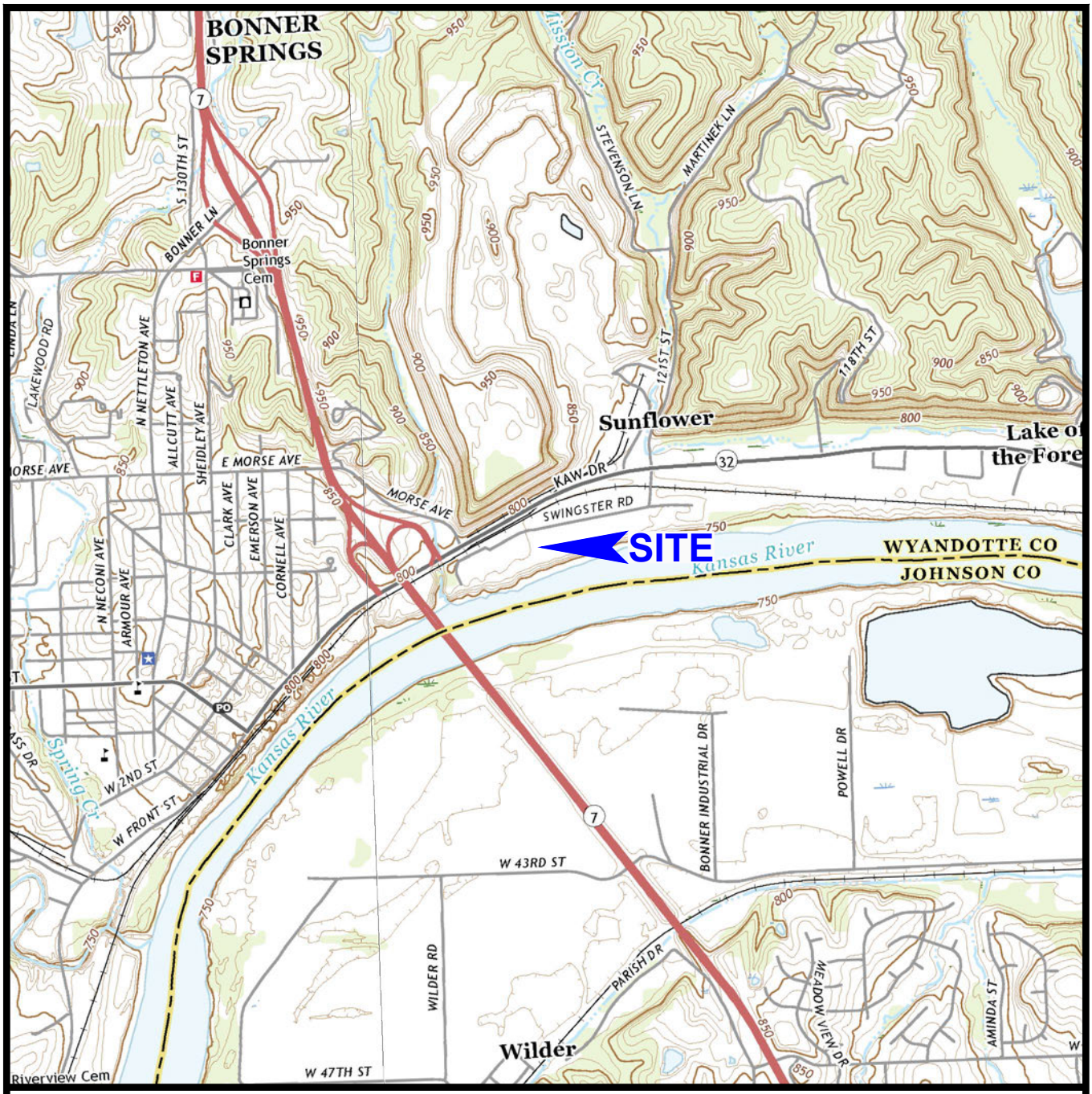
Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@geoprofessional.org www.geoprofessional.org

APPENDIX B

Site Location and Topography - Figure 1
Aerial Photograph of Site and Boring Location - Figure 2



NOTES

1. Plan adapted from 7.5 minute U.S.G.S. maps for Edwardsville and Bonner Springs, Kansas quadrangles, last revised in 2018.

0 2,000 4,000

SCALE IN FEET

N

Drawn By: WAH	Ck'd By: SDG	App'vd By: MHM
Date: 4-17-20	Date: 4-17-20	Date: 4-17-20

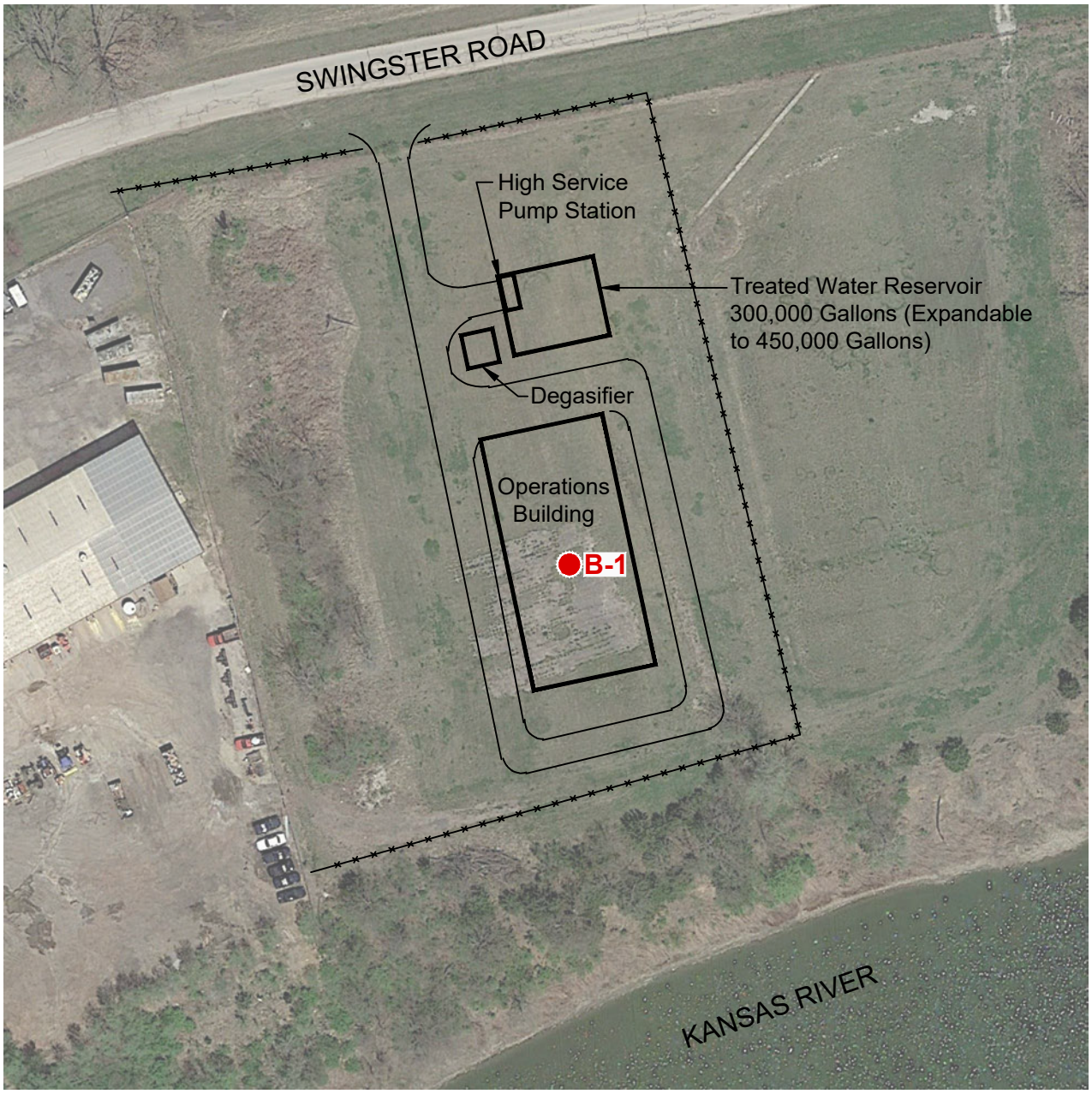
GEOTECHNOLOGY INC
FROM THE GROUND UP

Water Supply and Treatment Plant Study
Bonner Springs, Kansas

SITE LOCATION AND TOPOGRAPHY

Project Number J035801.01

FIGURE 1



NOTES

1. Plan adapted from an April 27, 2018 aerial photograph courtesy of Google Earth and an undated drawing titled "Alternative No. 3, Membrane Softening Site Plan" prepared by Black & Veatch Corporation.

2. The boring was located in the field with reference to site features and is shown approximate only.

LEGEND

● Boring Location

0 100 200

SCALE IN FEET

N

Drawn By: WAH	Ck'd By: SDG	App'vd By: MHM
Date: 4-17-20	Date: 4-17-20	Date: 4-17-20

GEOTECHNOLOGY INC
FROM THE GROUND UP

Water Supply and
Treatment Plant Study
Bonner Springs, Kansas

AERIAL PHOTOGRAPH OF SITE AND BORING LOCATION

Project Number
J035801.01

FIGURE 2

APPENDIX C

Log of Boring B-1
Boring Log: Terms and Symbols

Surface Elevation 789 | Completion Date: 4/2/20

Datum WGS84

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL - dark brown, fat clay, with asphalt fragments		
	CLAY - dark brown to brown, fat, medium stiff to stiff - (CH)	1-2-4	SS1
		97	ST2
5		2-2-4	SS3
		88	ST4
10			
		96	ST5
15			
		85	ST6
20			
	brown and gray	1-1-3	SS7
25			
		2-3-5	SS8
30			
		3-5-6	SS9
35			
		2-3-5	SS10
40			
	SAND - light brown to brown, fine to coarse, medium dense and dense, trace silt - SP	5-9-12	SS11

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

91 >>

79 >>

83 >>

Estimated Lowest Slab

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 45 FEET

DJT DRILLER RFJ LOGGER

CME 55 trk DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RFJ	Check by: SDG	App'vd by: MHM
Date: 4/2/20	Date: 4/16/20	Date: 4/17/20

GEOTECHNOLOGY INC
FROM THE GROUND UP

Water Supply and Treatment Plant Study
Bonner Springs, Kansas

LOG OF BORING: B-1

Project No. J035801.01

Surface Elevation 789 | Completion Date: 4/2/20

Datum WGS84

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	SAND - light brown to brown, fine to coarse, medium dense and dense, trace silt - SP *(continued)*			
			12-18-17	SS12
50				
			10-11-12	SS13
55				
			13-13-17	SS14
60				
	some gravel		6-6-5	SS15
65				
			10-10-11	SS16
70				
			9-10-11	SS17
75				
			11-13-5	SS18
80				
	SHALE or BOULDER (no sample recovery)		50/3"	SS19
85	Boring terminated at sampler refusal at 83.8 feet.			

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 □ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 45 FEET

DJT DRILLER RFJ LOGGER

CME 55 trk DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RFJ	Check by: SDG	App'vd by: MHM
Date: 4/2/20	Date: 4/16/20	Date: 4/17/20

GEOTECHNOLOGY INC
FROM THE GROUND UP

Water Supply and Treatment Plant Study
Bonner Springs, Kansas

CONTINUATION OF LOG OF BORING: B-1

Project No. J035801.01

BORING LOG: TERMS AND SYMBOLS

GENERAL NOTES

1. *Information on each boring log is a compilation of subsurface conditions based on soil or rock classifications obtained from the field as well as from laboratory testing of samples. The strata lines on the logs may be approximate or the transition between the strata may be gradual rather than distinct. Water level measurements refer only to those observed at the times and places indicated, and may vary with time, geologic condition or construction activity.*
2. *Relative composition and Unified Soil Classification designations are based on visual estimates and are approximate only. If laboratory tests were performed to classify the soil, the unified designation is show in parenthesis.*
3. *Value given in Unit Dry Weight/SPT Column is either a unit dry weight in pounds per cubic foot, if adjacent to a ST sample designation, or blows per 6-inch increment if adjacent to a SS sample designation.*

ABBREVIATIONS

UU/2	*Shear Strength from Unconsolidated – Undrained Triaxial Test (ASTM D2850)*
QU/2	*Shear Strength from Unconfined Compression Test (ASTM D2166)*
SV	*Shear Strength from Field Vane (ASTM D2573)*
PL	*Plastic Limit (ASTM D4318)*
LL	*Liquid Limit (ASTM D4318)*

LEGEND

CS	Continuous Sampler
GB	Grab Sample Taken From Auger Cuttings or Wash Water Return
NX 100/42	NX Rock Core with Percent Recovery/R.Q.D. Given In Adjacent Column
PST	Three Inch Diameter Piston Tube Sample
SS	Split Spoon Sample (Standard Penetration Test)
ST	Three Inch Diameter Shelby Tube Sample
*	Sample Not Recovered
SV	Field Vane Test

SPLIT – BARREL SAMPLER DRIVING RECORD

Blow per Foot (N-Value)	*Description*
25	*25 blows drove sampler 12 inches after initial 6 inches of seating.*
75/10”	*75 blows drove sampler 10 inches after initial 6 inches of seating.*
50/S3”	*50 blows drove sampler 3 inches during initial 6 inch seating interval.*

NOTES: 1. *To avoid damage to sampling tools, driving is limited to 50 blows during any six inch interval.*
2. *N-Value (Blow Count) is the standard penetration resistance based on the total number of blows, using a 140-lb hammer with 30-inch free fall, required to drive a split spoon the last two of three, 6-inch drive increments. (Example: 4/7/9, N = 7 + 9 = 16). Values are shown as a summation on grid plot and may be shown as 4/7/9 in Unit Dry Weight – SPT column.*

RELATIVE COMPOSITION

Trace……...0-10 %
With/Some……...11-35 %
Soil modifier such…... > 35 %
As silty, clayey, sandy, etc.

DENSITY OF GRANULAR SOILS

Descriptive Term:	***N—Value***
Very Loose	*0 - 4*
Loose	*5 - 10*
Medium Dense	*11 - 30*
Dense	*31 - 50*
Very Dense	*> 50*

STRENGTH OF COHESIVE SOILS

Consistency	***Undrained Shear Strength Tons Per Sq. Ft.***	***Field Test***	***Approximate N-Value Range***
Very Soft	*less than 0.12*	*Thumb will penetrate soil more than 1”*	*0 - 1*
Soft	*0.13 to 0.25*	*Thumb will penetrate soil about 1”*	*2 - 4*
Medium Stiff	*0.26 to 0.50*	*Thumb will penetrate soil about ¼”*	*5 – 8*
Stiff	*0.51 to 1.00*	*Thumb hardly indents soil*	*9 – 15*
Very Stiff	*1.01 to 2.00*	*Thumb will not indent soil, but readily indented with thumbnail*	*16 – 30*
Hard	*greater than 2.00*	*Thumbnail will not indent soil*	*> 30*

SOIL GRAIN SIZE

U.S. STANDARD SIEVE

12”	3”	¾“	4	10	40	200		
BOULDERS	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		
300	76.2	19.1	4.76	2.00	0.42	0.074	0.002	

SOIL GRAIN SIZE IN MILLIMETERS

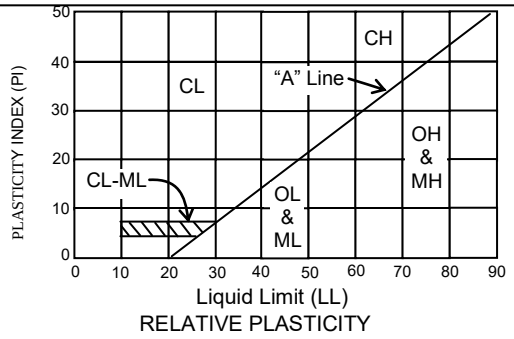
SOIL STRUCTURE

Calcareous *– Having appreciable quantities of carbonate.*
Fissured *– Containing shrinkage or relief cracks, often filled with sand or silt; usually more or less vertical.*
Slickensided *– Having planes of weakness that appear slick and glossy. The degree of slickensidedness depends upon the spacing of slickensides and the ease of breaking along those planes.*
Layer *-- Inclusion greater than 3 inches thick.*
Seam *– Inclusion 1/8 inch to 3 inches thick extending through the sample*
Parting *– Inclusion less than 1/8 inch thick.*
Pocket *– Inclusion of material of different texture that is smaller than the diameter of the sample.*
Interlayered *– Soil samples composed of alternating layers of different soil types.*
Intermixed *– Soil samples composed of pockets of different soil types and a layered or laminated structure is not evident.*
Laminated *– Soil sample composed of alternating partings or seams of different soil type.*

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			SYMBOL	DESCRIPTION
Coarse-Grained Soils (More than 50% Larger than No 200 Sieve Size)	Gravel and Gravelly Soils	Clean Gravels Little or no Fines	GW	Well-Graded Gravel, Gravel-Sand Mixture
			GP	Poorly –Graded Gravel, Gravel-Sand Mixture
		Gravels with Appreciable Fines	GM	Silty Gravel, Gravel-Sand-Silt Mixture
			GC	Clayey-Gravel, Gravel-Sand-Clay Mixture
	Sand and Sandy Soils	Clean Sands Little or no Fines	SW	Well-Graded Sand, Gravelly Sand
			SP	Poorly Graded Sand, Gravelly Sand
		Sands with Appreciable Fines	SM	Silty Sand, Sand-Silt Mixture
			SC	Clayey Sand, Sand-Clay Mixture
Fine-Grained Soils (More than 50% Smaller than No 200 Sieve Size)	Silts and Clays	Liquid Limit Less Than 50	ML	Silt, Clayey Silt, Silty or Clayey Very Fine Sand, Slight Plasticity
			CL	Clay, Sandy Clay, Silty Clay, Low to Medium Plasticity
			OL	Organic Silts, or Silty Clays of Low Plasticity
	Silts and Clays	Liquid Limit More Than 50	MH	Silt, Fine Sandy or Silt Soil with High Plasticity
			CH	Clay, High Plasticity
			OH	Organic Clay of Medium to High Plasticity
	Highly Organic Soils		PT	Peat, Humus, Swamp Soil

PLASTICITY CHART



RELATIVE PLASTICITY

Nonplastic	Cannot Roll Into Ball
Trace Plasticity	Barely Roll Into Ball
Medium Plastic	Can be Rolled Into Ball
Highly Plastic	No Rupture by Kneading

VISUAL DESCRIPTION CRITERIA*

TABLE 1: CRITERIA FOR DESCRIBING ANGULARITY OF COARSE-GRAINED PARTICLES

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

TABLE 2: CRITERIA FOR DESCRIBING PARTICLE SHAPE

Description	Criteria
Flat	Particles with width/thickness X3
Elongated	Particles with length/width X3
Flat and Elongated	Particles meet criteria for both flat and elongated

TABLE 3: CRITERIA FOR DESCRIBING MOISTURE CONDITION

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp, but no visible water
Wet	Visible free water, usually soil is below the water table

TABLE 4: CRITERIA FOR DESCRIBING REACTION WITH HCL

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming rapidly

TABLE 6: CRITERIA FOR DESCRIBING CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

*NOTES: 1. Tables adapted from ASTM D2488 "Description and identification of Soils" (Visual-Manual Procedure)
2. Tables 5, 7 and 11 incorporated into other information on this plate.

TABLE 8: CRITERIA FOR DESCRIBING DRY STRENGTH

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9: CRITERIA FOR DESCRIBING DILATANCY

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

TABLE 10: CRITERIA FOR DESCRIBING TOUGHNESS

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

TABLE 12: IDENTIFICATION OF INORGANIC FINE-GRAINED SOILS FROM MANUAL TESTS

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	none	High